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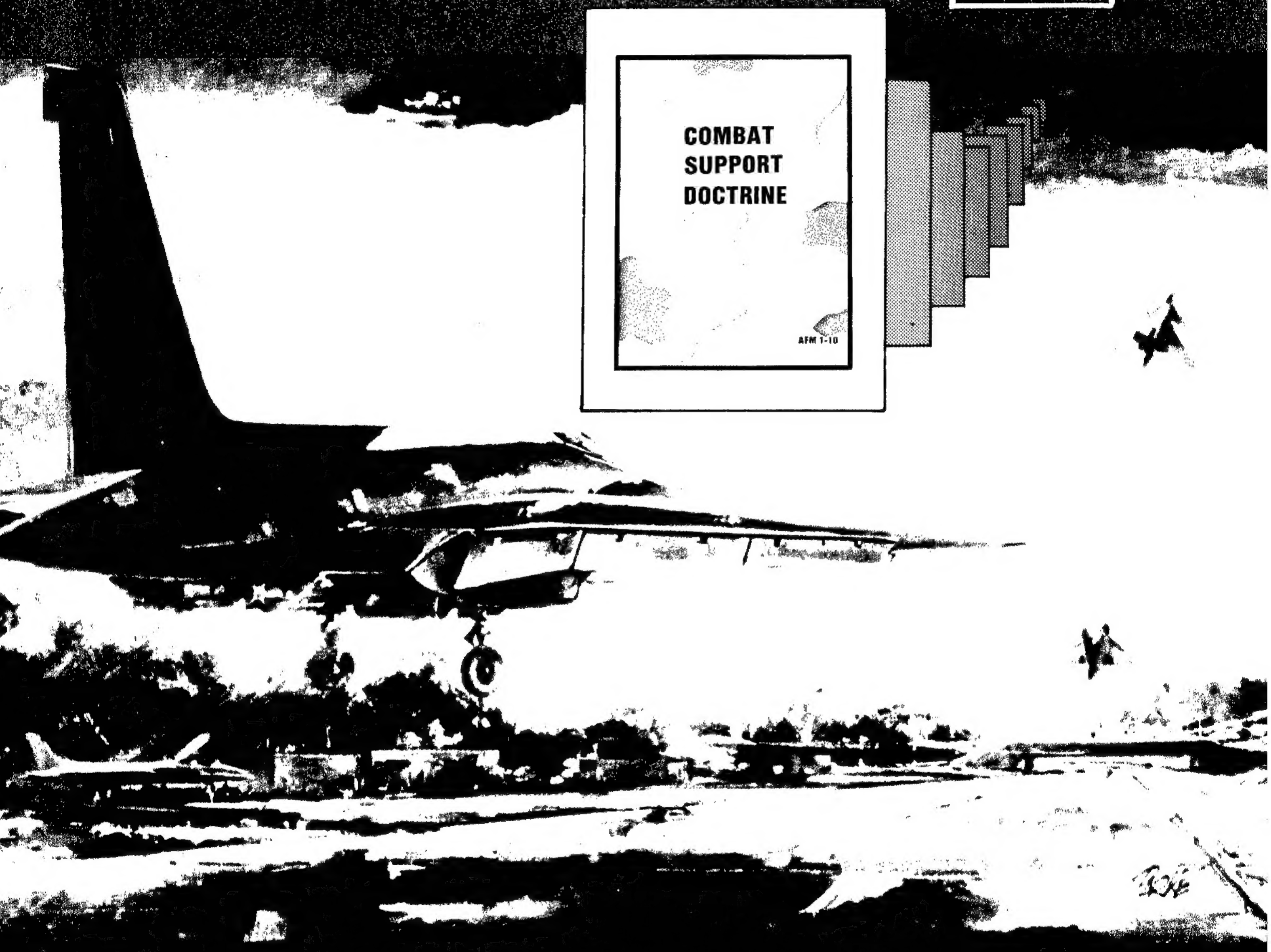

COMBAT SUPPORT DOCTRINE?

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Purpose The *Air Force Journal of Logistics* provides an open forum for the presentation of issues, ideas, research, and information of concern to logisticians who plan, acquire, maintain, supply, transport, and provide supporting engineering and services for military aerospace forces. It is a non-directive, quarterly periodical published under AFR 5-1. Views expressed in the articles are those of the author and do not necessarily represent the established policy of the Department of Defense, the Department of the Air Force, the Air Force Logistics Management Center, or the organization where the author works.

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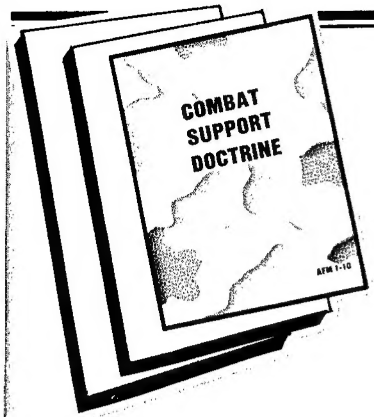

All Air Force logisticians have but one common goal: to win the war. The problem is the best way to reach that objective. This special section features a glimpse into the future of Combat Support Doctrine, some different viewpoints on doctrine, and the need for civil engineering doctrine. These articles should stimulate your thinking about and defining Combat Support Doctrine for today and tomorrow.

Organizing for Combat Support in the Twenty-First Century

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Understand: War is hell! Even under the best circumstances the fog and friction of war will dictate how we operate, what we are able to accomplish, and, of course, our ability to meet whatever challenges we face. As we approach the twenty-first century, it is time to take a fresh look at how we are organized. A basic Air Force premise is to organize in peace as we would operate in war. The question posed is whether the current tri-deputate system meets that goal. Perhaps the time is ripe to reflect on the past as well as think about where we need to go in the future.

Definitions

As we launch into this arena, it is important to provide a framework for the discussion by looking at current JCS definitions of combat support and logistics, and what current combat support doctrine states. JCS Pub 1, *Dictionary of Military and Associated Terms,* does not contain a definition for combat support; however, the recognized term in the joint arena is "combat service support." The term is defined as:

The assistance provided operating forces primarily in the fields of:

Administrative Services	Supply
Chaplain Services	Maintenance
Civil Affairs	Transportation
Finance	Construction
Legal Services	Troop Construction
Health Services	Acquisition and Disposal of Real Property
Military Police	Facilities Engineering
Bath	Topographic and Geodetic Engineering Functions
Food Service	Laundry and Dry Cleaning
Graves Registration	Other Logistic Services
Property Disposal	

This definition encompasses a vast majority of the entire spectrum of the Air Force and cuts across the responsibilities assigned to the Combat Support Group Commander, Deputy Commander for Resources, and Deputy Commander for Maintenance. It is essential, however, to have a clear understanding of the term "combat support" so we can better understand the significance of the arguments on why it is essential that the Air Force look at a possible reorganization.

Before we leave the definitional phase, we need to consider the JCS definition of logistics:

The science of planning and carrying out the movement and maintenance of forces. In its most comprehensive sense, those aspects of military operations which deal with:

a. Design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel.

b. Movement, evacuation, and hospitalization of personnel.

c. Acquisition or construction, maintenance, operation, and disposition of facilities.

d. Acquisition or furnishing of services.

As we compare these two definitions, we see that there is much overlap, and logistics could be considered almost synonymous with combat support.

I think Admiral Ernest J. King best sums up the problems logisticians often face when he stated: "I don't know what the hell this 'logistics' is that Marshall is always talking about...but I want some of it."

Doctrine

These broad definitions provided the framework for the development of AFM 1-10, *Combat Support Doctrine*. The Doctrine describes the Combat Support Process as eight basic processes by which Air Force combat operational needs are met: (1) definition, (2) acquisition, (3) maturation, (4) distribution, (5) integration, (6) preservation, (7) restoration, and (8) disposition. To carry out the combat support process, eight principles have been established which explain what makes combat support work best:

Objective:	Know what you want to do before you do it and keep reminding everyone until it's done.
Leadership:	You are the single most important factor in achieving military victory.
Effectiveness:	Do only those things that improve combat capability.
Trauma/Friction:	Understand: war is hell.
Balance:	Get the right thing in the right amount to the right place at the right time.
Control:	Never lose contact with your resources.
Flexibility:	Create aerospace forces that can operate in any combat environment.
Synchronization:	Combat Support + Combat Operations = Combat Power

The role of doctrine is to offer guidance to Air Force leaders to: (1) learn from the past, (2) act in the present, and (3)

influence the future. The doctrine describes combat support as the art and science of creating and sustaining combat capability. Based on the combat support doctrine, the Logistics and Engineering community developed the Logistics Concept of Operations (see *AFJL*, Winter 88, for complete explanation). The concept is equally applicable to all phases of combat support.

This definitional and doctrine background provides the necessary framework to proceed with a proposal for reorganization. The old adage "if it ain't broke don't fix it" always has to apply, but one of the basic tenets of the Air Force is we need to organize in peace as we expect to operate in war.

Current Organization

Before proceeding, it is important for us to review the current wing organization. It should be noted that we have conducted numerous exercises, but we have never been involved in a conflict that was supported by the tri-deputate system.

Wing Commander
- Safety
- Hospital
- Public Affairs
- Social Actions
- History

Deputy Commander for Operations
- Operations Staff
- Flying Squadrons
- Intelligence
- Plans

Deputy Commander for Maintenance
- Maintenance Staff
- Flight Line
- Intermediate
- Munitions Storage

Deputy Commander for Resources
- Transportation
- Plans
- Supply
- Contracting
- Comptroller

Combat Support Group
- Personnel
- Administration
- Civil Engineers
- Security Police
- Chaplain
- Judge Advocate General (JAG)
- Services
- Disaster Preparedness
- Base Operations and Training
- Morale, Welfare and Recreation (MWR)

This organization needs to support both peacetime and wartime functions. The peacetime functions are many and varied; for example, training aircrew, maintaining aircraft, meeting the flying schedule, providing resources to the base, managing budgets, planning for war, keeping the base in good shape, providing security, and taking care of families. Looking at the wartime functions, however, we focus on combat projection (launching aircraft). The second major task is keeping the air base operating, runways open, facilities maintained or ready, and air base defended (keeping the people viable and protecting the base resources). The final wartime function is replacing consumed items, munitions, fuel, and spares.

Peacetime/Wartime Functions

The difference between the peacetime functions and the wartime functions was clearly pointed out in SALTY DEMO when the conclusions indicated our peacetime management perspective for manpower, organization, and training is one of functional/technical specialization. The result is a "corps mentality" which needs to be broken down to ensure success in a wartime situation. Silver Flag, a TAC exercise to train a deployed combat support force to ensure essential services are established and maintained, also pointed out we need to overcome our "union card" mentality. Development of teamwork was absolutely essential for the success of maintaining essential services in a combat environment.

We have briefly touched on definitions, doctrine, current organization, and peacetime/wartime functions. Let us turn now to how, where, and who goes to war. There are two basic ways for Air Force units to go to war:

(1) *Overseas units generally fight in-place*. These units have a definite advantage because the wing infrastructure does not change. For the most part, the personnel assigned know their way around the base, who can be trusted to get the job done, where facilities are located, and what they are expected to accomplish. If they have a wartime additional duty, they have been trained and have practiced this duty. In other words, the in-place forces are ready to meet their wartime functions: combat projection, keeping the air base operating, and replacing consumed items with very little transition time.

(2) *By deploying*. A typical unit deploys with an aviation package, which provides minimum functions to fight for 30 days. This is followed by the intermediate package, which provides additional support to the aviation package. A third major package, the headquarters support package, functions to provide services to the deployed personnel. Units that deploy in this manner are generally located in the United States and deploy to support one of the Unified CINCs. The majority of deployed forces do not go to US operated bases, but rather deploy to bases which are often allied airfields.

When a deploying squadron arrives at a collocated operating base (COB), it is expected to be combat ready immediately. However, there are some enormous problems that the commander must overcome. First, there is no US operating infrastructure; it must be established. This deployment may be the first time units have worked together. To highlight the problem further, following are the personnel for a typical squadron deployment. The personnel do not always come from the home base.

Home Base	Other Units
Personnel (85%)	Personnel (15%)
Operations (100%)	Communications (76%)
Maintenance (100%)	Medical (29%)
Munitions (100%)	Battle Damage Repair (100%)
PRIME BEEF (100%)	Transportation (2%)
Security (100%)	Combat Support Group (40%)
Civil Engineering (78%)	Petroleum, Oil and Lubricants/Liquid Oxygen (POL/LOX) (14%)
Combat Support Group (CSG) (60%)	Reception (100%)
Petroleum, Oil and Lubricants/Liquid Oxygen (POL/LOX) (86%)	Disaster Preparedness (46%)
Medical (71%)	
Transportation (98%)	
Disaster Preparedness (54%)	
Communications (24%)	Total Personnel: 1200

It will be necessary for this commander to integrate into the unit approximately 200 people, from a variety of places, that in many cases have never worked with each other—let alone the people from the home base. From this example, we see that at the COB we have problems not faced by the main operating location:

(1) Command management team is in-place. At this deployment site for the areas supported by other units, who is in charge?

(2) Personnel know their wartime jobs. Have personnel been trained in rapid runway repair or air base defense, or camouflage, concealment, and deception, or any number of other things required for a unit to generate, survive, defend, and recover after attack. These are extremely important tasks, and the commander has the responsibility to ensure the unit can accomplish this mission.

(3) At a main operating base, everyone is familiar with the base. At the deployment site there will be many people arriving who have never been to that location. The sample unit described has been to its wartime location twice in the past four years. How many people will have PCSed in that time frame? How many support people will have actually gone to the wartime location?

(4) Another problem faced by units deploying to COBs is they have not practiced together. In our example, only 85% of the unit had practiced together, but have they practiced as if they were at their wartime location? What about the 15% that come from other locations? How are they practicing their wartime mission?

The groundwork has been laid for the need for change. It starts with how we define support and carries through our doctrine and into the realities of wartime deployments.

The wartime functions previously mentioned will more than likely not change in the twenty-first century. What will change are the threat, strategy, reliability of aircraft and spares, types of aircraft, and increased automation.

Major General George Ellis, Director of Engineering and Services, HQ USAF, recently stated in *AIRMAN:*

> We need to reorganize the combat support structure. Current combat support group commanders at base level under the tri-deputy system don't have the support they need. They don't have supply, transportation, repair and maintenance, and medical people at their disposal. Combat support embodies all those things—not just the cops and engineering and services folks. If you're going to give a combat support guy the responsibility to fight for that air base, then he needs some of those resources under his command. And he needs to train with them before he goes to war. You can't do it once you get there. A war isn't going to last that long.

If we accept the premise that perhaps there is a need for reorganization to ensure we are to organize in peace as we are to operate in war, then it makes sense that we should organize around the combat functions. The current tri-deputate system classifies functions together that operate during peacetime without regard to how a squadron goes to war or the combat functions: Combat projection, keeping the air base operating, and replacing consumed items.

- What does it take for *combat projection?* If we look at what currently deploys first, we find it consists of operations, flight-line maintenance/munitions, war readiness spares kit (WRSK), intelligence, and weather. Why not organize around this requirement?
- What is necessary to keep the *air base operating* in wartime? Civil engineers, services, security policy, disaster preparedness, communications, and base operations. Why not organize around this requirement?
- What is necessary to *replenish the base* in wartime? Intermediate maintenance, supply, transportation, contracting, plans, and munitions storage. Why not organize around this requirement?

The remaining organizations—personnel, comptroller, administration, history, MWR, JAG, social actions, public affairs, and medical—all provide essential services so the air base can operate efficiently. Why not organize around this requirement?

This envisioned organization would look like this:

Combat Projection	Base Operations
Operations	Civil Engineers
Flight-line Maintenance/	Services
Munitions	Security Police
WRSK	Disaster Preparedness
Intelligence	Communications
Weather	Base Operations

Replenishment	Services
Intermediate Maintenance	Personnel
Supply	Comptroller
Transportation	Administration
Contracting	History
Plans	JAG
Munitions Storage	Social Actions
	Public Affairs
	Medical
	Morale, Welfare and Recreation

The final question is, of course, why not organize around the combat functions? As further discussion takes place on this subject, evolving organizations may not look at all like the one presented; but it is time to begin thinking about how we are going to meet the challenges facing us in the twenty-first century.

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Recommended Reading:

GORALSKI, Robert and Russell W. FREEBURG. *Oil & War: How the Deadly Struggle for Fuel in WWII Meant Victory or Defeat* (New York: William Morrow & Co. Inc, 1987) (384 pages including an excellent bibliography).

Some Thoughts on Combat Support Doctrine (AFM 1-10)

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During a recent briefing on warfighting, I heard the term "combat support" described as that element of the overall combat organization which provides direct and immediate assistance to forces engaged in combat. The terms "direct" and "immediate" imply that combat support has spatial and temporal reference points. Carrying this line of thought further, one could make a case that combat support is limited to an operational theater if it directly and immediately assists those forces engaged in combat. If combat support can, due to space and time, be seen as theater limited, and the likelihood of a long war of attrition only a remote possibility, then perhaps we should take a different approach to combat support. That approach should emphasize speed, high consumption rates, and concentrated effort with little or no lead time. It is an approach not considered by the current AFM 1-10, *Combat Support Doctrine*.

If we ever hope to see combat support related to Air Force doctrine, we need to see how combat support fits in with the elements of warfare (Firepower, Maneuver, Logistics) that form the basis for the Principles of War as they are presented in AFM 1-1, *Basic Aerospace Doctrine*. Strangely, the word "logistics," which is included in the very heart of AFM 1-1, is only mentioned twice in AFM 1-10. Apparently, combat support and logistics are not interchangeable in the eyes of the Air Force. Combat support, however, has always been a troublesome term for me. For example, what does the combat support group commander have to do with combat? Perhaps the term "combat support" is misused all too often. Certainly, we need to ask ourselves if we employ combat support (or for that matter the combat support group commander) in the same way we employ those forces discussed in AFM 1-1. We know that PRIME BEEF teams may be repairing runways during combat, but is their combat support group commander capable of calling in a close air strike or directing the ground defense of the air base? Could this mean that the combat support group commander does not really employ resources in a combat sense? Another troubling notion is that our doctrinaires believe that combat support programs such as the Planning, Programming and Budgeting System (PPBS) directly relate in terms of time and space to those maintenance troops (commanders included) sitting in nuclear, biological, chemical (NBC) shelters waiting to generate the next sortie. Both concepts are support; yet, only one is combat. Maybe we have been misusing the word "combat" in our rush to label everything and everyone as warfighting/warriors.

VIEWPOINT

What's Wrong with AFM 1-10?

Chapter 1 of AFM 1-1 says, "Once the decision to use military force is made, doctrine describes the best way to employ military forces to achieve objectives." If we can assume that our basic doctrine is correct, then we should be able to evaluate other doctrinal issues in light of AFM 1-1. AFM 1-10 does not seem to align very well with our basic doctrine. It appears that it was written in isolation—perhaps as a stand-alone document that does not consider the relevance of support to actual employment.

If we subscribe to the idea that our basic doctrine is correct, then we must give some credibility to the ideas of speed and flexibility that characterize our aerospace forces. The current *Combat Support Doctrine* is the antithesis of speed and flexibility. With all its discussion about the PPBS and acquisition processes, I wonder if the intent is to further institutionalize an entrenched bureaucracy of contracting officials instead of telling us how to fight a war. What became of the "simple, secure, and flexible" logistics system advocated by our basic doctrine? By focusing on an industrial process, we are dooming a significant percentage of the air forces to thinking in terms of wars of attrition alone. I think that AFM 1-10 actually ignores major portions of the spectrum of violence. The manual is irrelevant to either low-intensity conflict or a violent "short war" in Europe. There is little likelihood that we will ever again see the sort of industrial preparations that led up to the D-Day invasion or anything close to it. Our combat support doctrine as reflected in AFM 1-10 seems frozen in time (1945?). I do not believe there will be sufficient time to develop and acquire resources in our next war.

Combat Support Doctrine paints a worrisome, handwringing picture of our industry's reliance on foreign resources and products to run our war machine. When foreign resources and products (I suspect only those that are of strategic importance) are cut off, it is too late. Doctrine should tell me how to prevent or overcome any embargo. We should look at any cutoff as a provocation, subject to varying degrees of reciprocal actions, including military force. Supplier nations should be able to pick up a copy of our doctrine and, after reading it, become a little bit intimidated—not be confident that they can dictate the course of events.

Chapter 2 of AFM 1-10 takes us on an excruciating tour through what it calls the Combat Support Process. Again, are we actually talking about combat or are we relabeling some sort of life cycle management process? How in the world do we expect "combat support" commanders to make sense out of this chapter when they are fighting a war? Or preparing for one? Does this chapter relate to how commanders are going to employ their forces? Will they for example be "combat acquiring" or "combat maturing" anything that will affect the outcome of the battle? On the other hand, this chapter does address some relevant issues in the areas of Preservation, Distribution, and Restoration. But even so, the combat aspects discussed in these areas are

somewhat shallow and tend to address more of the "why" than the "how" of the process. And, still, there is no mention of employment.

The Combat Support Principles in Chapter 3 only seem to be addressing combat in a peripheral sense.

Objective: Long-range planning, programming, and budgeting dominate the thought processes involved with this principle.

Leadership: The discussion of this principle is probably more appropriate to one of those unceasing articles on professionalism versus careerism, and what all that means to our officer corps.

Effectiveness: By the time anyone is through digesting this principle, they should start wondering, if they haven't already, just why we have beat the subject of acquisition to death at the expense of any topics that have a direct and immediate effect on forces engaged in combat.

Trauma and Friction: This principle explains many bad things that could happen if we have faulty doctrine. I agree with this point; yet, I wonder why air base operability/survivability is not discussed in our doctrine as a means to address all these bad things that happen when Trauma/Friction exists. We need to know how to "employ" an entire air base—not that it will be "less than pleasant" in wartime. Talk about the tail wagging the dog—we need to rethink the principle of Balance. Do we want our leaders to believe that "a balance of resource use and resource conservation allows the combat support structure to meet the operational needs of the commander." Reckless use of resources may in fact carry the battle.

Balance: This principle flies directly in the face of the principles of Surprise, Timing and Tempo, and Mass. Was General Patton wrong to ignore his "combat support structure" when he outran his supply lines? Were the British wrong for using everything they had to retake Port Stanley in the Falkland Islands? I do not want to belabor the principle of Balance, but does a discussion on PPBS, promotions, assignments, and systems acquisition really address basic combat support doctrine, or is it again explaining/rationalizing the current peacetime system. Is this stuff applicable to warfighting, or what?

Control: This principle makes a very good point and I totally agree that a commander needs to maintain control/contact of resources.

Flexibility: This principle quite correctly addresses the worldwide distribution of resources which is logical if you have worldwide commitments. However, included in the description of Flexibility is an explanation of how it is accomplished. One method by which Flexibility is accomplished is through prepositioning. I have some trouble with this. Prepositioning offers flexibility only to the extent that forces deploy to predetermined locations. Is this flexible? What happens when governments change at our prepositioning locations or the political climate is such that we can draw from prepositioned stocks? How easily can we change weapon systems destined for those prepositioned locations? Is prepositioning a valid part of the Flexibility equation if we need to deploy to southern Africa?

VIEWPOINT

Synchronization: This principle makes one final pitch for justifying a severely bloated logistics tail. There is not a whole lot said about what is to be synchronized other than our "working relationships prior to deployment." Could this be a thinly veiled reference to the Quality Circle Program? In summary, there is not a lot of combat in the Combat Support Principles.

What Is Combat Support?

Before I discuss combat support, I would like to say what I think it isn't. Combat support is not life cycle analysis, the acquisition process, promotions and assignments, raw materials, or reliability and maintainability initiatives. None of this is combat. None of this has a direct and immediate effect on forces engaged in combat. None of this should be included in doctrine. The current *Combat Support Doctrine* manual is not only flawed because it shows a lack of understanding of doctrine, but it also shows an inability to define combat support. Now that I have stirred up the hornet's nest, here is my definition:

> **Combat Support:** Those elements of an operational force providing logistics in the communications zone, air field ground defense, and all aspects of airfield recovery and sortie generation that have a direct and immediate effect on air forces engaged in combat.

Or, since equations seem to be favored by our doctrinaires, we can say:

COMBAT SUPPORT =

LOGISTICS + AIR BASE OPERABILITY

I need to stress that this equation leaves out many elements of what the Air Force calls the "combat" support group (Military Personnel Office, morale, welfare and recreation, chapel, administration) and resource management (accounting and finance, contracting). Keeping this in mind, what do we need to address to describe the best way to employ military forces to achieve objectives?

Rewrite AFM 1-10?

Consider the vast sums of time and money invested in aircraft shelters. Should we not treat hardening as doctrine. It is, after all, the way we intend to employ. We hope to provide logistics and protection for our aircraft while generating hundreds of sorties in a hardened environment. Someone believes in this very strongly, yet we do not include it in doctrine. How about responsiveness? Aerial refueling is definitely a fast way to deliver supplies to a combat force. Tactical airlift becomes a force multiplier through rapid delivery of spares within a theater (C-23). Responsiveness is excluded from our doctrine, yet it is essential to resupply in any theater at any level of conflict. Since Murphy's Law applies to all warfighting scenarios, maybe airfield recovery should be considered as doctrine. After all, we do not intend to cease operations after the first bombs fall on our runway (and they will). We intend to make

multiple repairs to those same runways as a means to employ our forces. Since we have so many bases in forward areas, one would think we might make some doctrinal statement on the best way to protect them. During war, we will sustain forces through a zone of communications and we need to know how best to secure and control our lines of communication (which move over land in most cases). If one looks at a base map and where we locate our bases in Europe, for example, one might get the impression that dispersal is an important aspect of doctrine. Whether we do a good or bad job of dispersal is unrelated to the point that somebody gives it a lot of consideration at a lot of locations. Mobility is essential to the application of aerospace power in distant theaters and it gives us an organic capability to deploy and employ. It is this organic capability that determines the extent to which air power can be deployed as a credible force or merely a static display. Again, another important element is missing from doctrine.

The *Combat Support Doctrine* manual needs to be rewritten with a pertinent and much simpler look at doctrine. Presently, policy seems to take up the lion's share of AFM 1-10. This is not to say there is no room to discuss acquisition, budgeting, and programming. There is. However, that discussion does not belong in a basic doctrinal manual. Actually, a better statement of doctrine could be used to guide those policy decisions that are made in support of doctrine. Finally, let's keep our support doctrine simple and understandable by design and use of everyday language. *Combat Support Doctrine* won't accomplish anything at all if our leaders won't pick it up in the first place.

Combat Support Doctrine: Another Point of View

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The idea of discussing basic doctrine can send chills down the spines of many. Or, it may put many to sleep. But an understanding of basic doctrine is essential to understanding our role in national security.

I would like to provide another point of view concerning doctrine. This article attempts to explain for the novice what AFM 1-10, *Combat Support Doctrine*, is and how it relates to AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force*. In addition, I will also address the issue of the "Logistics Concept of Operations," an application stemming from Combat Support Doctrine.

Before discussing Combat Support Doctrine and its relationship to Basic Aerospace Doctrine, it is first important to understand the general concept of doctrine. AFM 1-1 identifies three general types of doctrine: basic, operational, and tactical. It further defines basic doctrine as a statement of officially sanctioned beliefs and principles used to describe and guide. Basic doctrine also serves to set up a common frame of reference. The Air Force 1-series manuals contain the basic doctrine and also provide the framework from which the Air Force develops operational doctrine. Operational doctrine is contained in the Air Force 2-series manuals which provide detailed mission descriptions and methods for preparing and employing aerospace forces. In turn, the basic and operational doctrines provide the framework from which the Air Force develops tactical doctrine, the Air Force 3-series manuals. Tactical doctrine considers tactical objectives and conditions and describes how specific weapon systems are employed to accomplish the tactical objectives. The doctrines become more specific in nature as we progress from basic, through operational, and finally to tactical.

A characteristic of doctrine is its non-specificity to time and technology. As General H. H. "Hap" Arnold points out in AFM 1-1, doctrine must be kept ahead of its equipment. Doctrine is not written to apply to a particular type of conflict in a set time period. Since new discoveries are constantly changing our capabilities, we will be faced with different types and intensities of violence. Therefore, doctrine should be sufficiently broad enough to take into account a wide spectrum of warfare and changes in environment. This requires doctrine to evolve, but does not require basic doctrine to change its fundamental principles. Indeed, the underlying principles of Basic Aerospace Doctrine have remained unchanged since the first aviation doctrine was enunciated in the mid-1920s. As Annex A of AFM 1-1 points out, shifts in the applications of airpower missions have not prompted changes to basic doctrine. In response to changes in time, technology, and theaters of operations, there should be changes to doctrine at the operational and tactical levels, but not at the basic level. What will certainly change will be the expansion of basic doctrine through the operational and tactical doctrinal levels.

AFM 1-10 is also a basic doctrine and follows the concept of doctrine as defined in AFM 1-1. It contains fundamental beliefs to serve as a guide to combat support. The entire manual was written purposely in a broad sense to enable commanders to adapt to any change in environment and technology. Contrary to the assertions of some, AFM 1-10 is closely related to AFM 1-1 in the sense that it expands upon and complements Basic Aerospace Doctrine.

Before undertaking an analysis of "combat support," it is again essential that one knows what the term means. First and foremost, combat support does not have a static definition. Depending on a variety of factors, including the scope and level of command, this term will have different meanings. At the base level, the base commander will consider all Combat Support Group functions (Military Personnel Office; Morale, Welfare, and Recreation; chapel; administration; legal; and engineering services) as combat support. At a theater or Numbered Air Force

level, combat support will be more logistically oriented—getting the weapon systems, weapons, munitions, and supply parts to the combat zone. So, what is combat support at a doctrinal level? At this level, it involves more than just logistics. Combat support includes equipping, sustaining, and training aerospace forces. This is how AFM 1-10 expands upon and complements AFM 1-1.

Aerospace forces, quite simply, are those forces needed to fight an aerospace war. They include weapon systems, trained personnel, maintenance, parts, and supplies. All these elements are identified in Chapter 4 of AFM 1-1. While some may argue that basic combat support doctrine should emphasize the basic Air Force logistics function, for AFM 1-10 to address solely those areas would restrict the intent of the basic doctrine. Instead, Chapter 2 of AFM 1-10 describes eight processes. These processes provide the peacetime infrastructure upon which the Air Force builds its aerospace forces. More importantly, the doctrine is stated flexibly enough to meet the greatest challenge presented in AFM 1-1: "to equip today's forces sufficiently while developing the aerospace forces to fight and win tomorrow's war."

It is important to make a fine but essential distinction. Basic Aerospace Doctrine identifies the need for speed and flexibility to characterize our aerospace forces. It would be easy to raise a stinging criticism of various combat support systems as being the antithesis of speed and flexibility. However, this is not a valid criticism of AFM 1-10. Like Basic Aerospace Doctrine, Combat Support Doctrine is broadly written. It details those *processes* which are used to provide aerospace forces to accomplish the equally broad goals of AFM 1-1. Whether the *system* that is developed to accomplish a particular process is fast and flexible is a measure of that system's success in fulfilling its basic goals. Indeed, it may be basic Combat Support Doctrine that identifies the failure of one of its implementing systems. For example, consider our current acquisition system. One can certainly criticize it as being slow, cumbersome, and unresponsive. But is is important to recognize that system as an implementing system of Combat Support Doctrine. In short, the validity of basic Combat Support Doctrine is not measured by its speed and flexibility, but rather by the speed and flexibility of the implementing systems it spawns.

Another one of the implementing systems is the logistics system. One may also criticize this as being slow. For this very reason, the Air Force Logistics Concept of Operations was developed to support the doctrine. It serves to bridge the gap between the doctrine, implementing plans and policies at theater and unit levels. The concept contains nine elements which provide the bases for individual theater concepts and is intended to respond directly to operational requirements. These elements include command and control, mutual support, depot support, forward support, allied/joint support, inter- and intra-theater transportation, mobility, and air base operability. Oddly enough, the inclusion of air base operability under combat support is an idea shared by others. In sum, a responsive logistics system strengthens our combat support through increased capability. Therefore, it is this system that we must improve.

In conclusion, the current *Combat Support Doctrine* (AFM 1-10) is sound. As with all doctrines, it contains fundamental beliefs to serve as a guide. It is also closely tied to the *Basic Aerospace Doctrine* (AFM 1-1). The challenge is to develop systems in support of the doctrine that meet operational needs during combat.

The "Logistics Concept of Operations" was developed to meet this challenge. What we yet need to develop are improved implementing systems for equipping and training our aerospace forces for combat support.

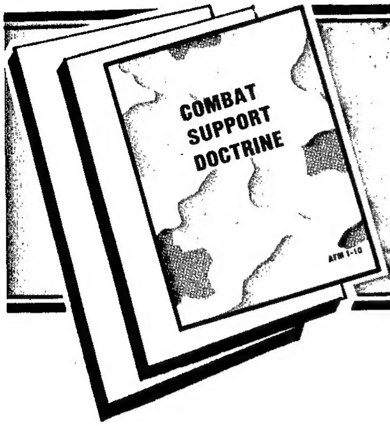
VIEWPOINT

Combined Air Warfare Course

The Combined Air Warfare Course, which is a part of the Center for Aerospace Doctrine Research and Education (CADRE), Maxwell AFB, Alabama, provides mid-career officers with a chance to explore the operational side of warfare through four weeks of lectures and seminars. Students from various career fields and other services are given an opportunity to act as a senior combined staff. They are responsible for preparing a theater air campaign plan for NATO's Central Region. Each plan is evaluated over a five-day period, using the Theater Warfare Exercise model, and critiqued by a general officer. The course is offered six times a year. Travel and per diem are paid for by Air University. For more information, contact Maj Green at AUTOVON 875-7831 or write to AU CADRE/EDW, Maxwell AFB AL 36112-5532.

Most Significant Article Award

The Editorial Advisory Board has selected "Coronet Warrior - A WRSK Flyout" by Captain Donald C. Pipp, USAF, as the most significant article in the Summer issue of the *Air Force Journal of Logistics*.



Civil Engineers: Doctrineless Warriors

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Introduction

Air Force Civil Engineers (CE) have a warfighting tradition which is etched on combat airfields around the world. Despite a long history of success, today engineers are doctrineless warriors. Sun Tzu once said:

> It is a doctrine of war not to assume the enemy will not come, but rather to rely on one's readiness to meet him; not to presume that he will not attack, but rather to make one's self invincible. (26:114)

As a civil engineer, I maintain CE doctrine is the guts of fighting and winning—without it we lose!

Although Engineering and Services, HQ USAF, has initiated a doctrinal study, Project Foundation, completion is a long way off. In the interim, engineers must prepare for this new doctrine—a guiding set of principles for future conflict—whether it be low-intensity conflict (LIC) or war in space. To win, we must have sound doctrine based on the successful experience of our predecessors.

Civil Engineers as Warfighters

Air Force CEs were warfighters before the Air Force was created and will continue to be warfighters. As Major General George E. Ellis, Director of Engineering and Services, HQ USAF, stated, "We must prepare to go to war . . . it's our number one priority . . . (to fight and win). The air base must do much more than survive—it must perform under fire." (9:8;8:3) Engineers will reconstitute the base as we have throughout history.

In World War II, airborne aviation engineers built runways in Algeria in 24 hours; while, in the Aleutians, they built runways in less than two weeks. (12:29,61;14:4) The Osan runway was built in five months; in Viet Nam, Rapid Engineer Deployable, Heavy Operational Repair Squadron, Engineer (RED HORSE) built one theater air base vulnerability (TAB VEE) shelter every seven days plus miles of revetments. (14:4) These warfighting actions were crucial to air base survivability.

Unfortunately, during the post-Viet Nam era, Air Force CE was overwhelmed with a peacetime mindset. A similar condition developed in the British Royal Navy in 1938. Admiral Sir Herbert Richmond stated, "The peacetime routine had corroded the military mind so that it lacked stimulation to think of war . . . ." (14:4) Fortunately, current CE senior leadership has reversed the negative trend, but what happened? I maintain CE lacked formal doctrine.

Doctrineless Warfighters

In 1941, Prime Minister Churchill could have summarized the plight of AF Civil Engineers when he described the German seizure of the British air base at Maleme, Crete.

> The enormous mass of noncombatant personnel who look after the very few heroic pilots . . . is an inherent difficulty in the organization of the Air Force . . . . Every airfield should be a stronghold of fighting air-groundsmen, and not the abode of uniformed civilians in the prime of life protected by detachments of soldiers. (9:8)

The British combat support force was not ready to fight—were they doctrineless warriors?

The AF has its basic doctrine, AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force,* and combat support doctrine, AFM 1-10, *Combat Support Doctrine;* however, civil engineering needs its own doctrinal warfighting principles. Doctrine is "what is officially approved to be taught . . . doctrine is also about what methods are to be used to carry out a military objective." Doctrine provides a "common thread . . . so everyone reacts as a cohesive, well-organized unit"; and doctrine provides the how-to or knowledge of warfighting. Our task is to formalize successful experiences of the past into doctrine. (17:9)

An inscription on a statue at the Air Force Academy states the role of doctrine well: "Man's flight through life is sustained by the power of his knowledge." (20:11) Civil engineering doctrine will underpin warfighting potential by "organizing, training, and equipping aerospace forces for employment." (7:14) Then based upon doctrine, adequate CE force structure can be created to sustain a viable warfighting capability.

Currently, AFM 1-10 provides an umbrella of combat support doctrine; however, supporting CE doctrine is necessary to provide a common thread for warfighting. (21:16;25:12;27:11) We have very few combat experienced engineers, i.e., World War II, Korea, Viet Nam, who can formalize engineering doctrine. (25:10) The bulk of combat experience is in the Air Reserve Forces (ARF). Seventy-five percent of CE officers have been commissioned since 1972. (14:9) Likewise, there is little written history of CE combat successes. Engineers are considered poor writers, and few publish technical articles, much less doctrinal articles. (25:12) Probably, very few have read AFM 1-1 or AFM 1-10, or pondered CE doctrine.

We have been poor students of history. Few have read Sun Tzu, Karl von Clausewitz, Liddell Hart, or other classic military strategists. Many engineers do not know their own history. Lieutenant Colonel Ashdown (Air War College student) and Captain Waggoner and Lieutenant Moe (AF Institute of Technology students) have captured CE history in

their theses, but these works must be living documents to serve as a baseline. (2:1-108;22:1-305)

Reviewing CE history does provide valuable lessons. It was an unresponsive Air Force CE peacetime mindset in combination with crises in Berlin (1961), Lebanon (1958), and Viet Nam (1965) that led to the creation of USAF CE Prime BEEF and RED HORSE forces; and these forces rebirthed a "warfighting mindset" that must be stimulated today. (25:10) The challenge is to formalize the mindset into a codifed engineering doctrine for use by our young officers and NCOs.

Doctrine's Importance in Warfighting

The best preparation for war is formal doctrine—the engineer behind fighting and winning. The written word must be indelibly ingrained into our CE leadership, both officers and noncommissioned officers (NCOs); however, developing doctrine is not easy. It will take years to hammer out CE doctrine, because doctrine is a wormy issue that is hard to work. As General Curtis LeMay once said:

> When I speak of air strength, I am not speaking only of airplanes. I am speaking of airfields . . . highly trained and skilled manpower—and airplanes. These constitute airpower. (10:6)

Air Base Survivability: Fighting and Winning

Sound doctrine would form the basis for CE's prime warfighting mission—air base survivability. Air bases are fixed Soviet targets. Civil engineers must recover bases after attack in the fog of war to ensure aircraft can be launched and recovered. Reliable utilities, roadways, and firefighting infrastructure are essential to support aircraft generation. To understand the complexity and fog of war, the Soviet threat must be examined.

> Surely the Soviets intend to compound the fog and friction of war. Soviet doctrine calls for the skillful exploitation of initiative, surprise, and shock to paralyze an enemy's will and destroy his morale. (20:10)

The Soviet attack may be SPETsNAZ or deep interdiction missions, special operations, airborne, and airlanded forces ". . . characterized by heavy and sporadic attacks with severe damage . . ." to the air base facilities. (3:2;23:4;25:11)

Consider the fictional cases of *Third World War: August 1985* and *Red Storm Rising*. In *Red Storm Rising*, the war was started using *Maskirovka* (deception), and Keflavik AB was attacked with Badgers, Backfires, and amphibious Hovercraft, and the air base was taken intact with follow-on airlanded forces. (6:98,176-178) In *Third World War: August 1985*, Sir General Hackett concludes:

> Cratering and mining (UXO's) were among the most disabling form of attack . . . . Rapid Runway Repair . . . paid off well . . . . They took the most casualties, especially from the delayed action mines . . . . (15:215)

This is a realistic picture of the threat and the nature of the CE battlefield. (25:11)

It will be tough to operate in that environment. In 1985, SALTY DEMO at Spangdahlem AB, Federal Republic of Germany (FRG), simulated a similar high tempo Soviet attack. The CEs learned some lessons: crater repair was deficient and sorties were lost, and engineers must train as they will fight. (9:9;25:11) SALTY DEMO showed basic combat skills were deficient; i.e., no integrated small arms teams, poor first aid, poor buddy care, and poor chemical defense. (23:6) SALTY DEMO was eye-opening, fingering weaknesses in CE warfighting.

Air base survivability was also weakened by CE deployment. In the past, the time-phased force deployment list (TPFDL) broke up CONUS combat support groups. For example, a wing's aircraft went to the FRG while its Prime BEEF team went to Guam. This created problems as the operator did not have "his" engineer. (14:6) Senior CE leadership now ensures engineers deploy with their peacetime operational unit. (5:15;9:9) Solid doctrine would have prevented this problem.

Lastly, air base survivability can be improved by obtaining dispersed operating bases which will ensure long-term survivability via mobility, concealment, and deception (3:2;29:19) This is a long-term solution as it takes time to work basing rights and prepositioning of supplies with the host nations. In the short-term, survivability is being enhanced by hardening facilities, tone down, camouflage schemes, and active defense. (3:2) Both approaches will enhance air base survivability.

By enhancing survivability, the CE force will have improved its warfighting capability, but now the doctrine must follow.

What CE Is Doing Right

Contrary to the impression you may have gotten from the preceding, Air Force CEs are doing many things right. In Europe the concrete slab rapid runway repair (RRR) technique is used for large craters versus the labor intensive AM-2 matting technique. Quick-setting polymer concrete is also being used for spall (cannon fire damage) repair. (13:12) Engineering training is more realistic with practice on blown craters in the annual Readiness Challenge wherein all Prime BEEF teams compete in combat engineering events. (11:34) The Readiness Challenge and the intense preparation it requires is rekindling the warfighting spirit within CE. (19:13;24:20)

Prime BEEF teams are being taught realistic wartime skills. ARF teams deploy to their wartime bases and perform target studies to locate and plot all critical utility systems and facilities. They also exercise at the base. All these actions help lay the foundation for effective doctrine.

Prime BEEF and RED HORSE teams have been restructured to improve integration with combat operations. The restructuring will identify the proper combination of skilled personnel to respond to contingencies be it LIC or higher levels of conflict. The teams will deploy with HARVEST EAGLE or HARVEST BARE facility mobility packages developed by the ARF to support mission beddowns. (4:23;28:24)

What About Doctrine: Where Should CE Be Headed

In developing doctrine for Project Foundation, action officers on the USAF/LEE staff should consider doctrinal work

done by Major General I. B. Holley (USAF, Ret) who believes:

> The search for doctrine becomes a matter of discovering the best way to arrive at sound generalizations about tactics and techniques . . . that represent only the most refined distillates from experience . . . . (16:2,4-5)

He suggests doctrine should be developed in three phases: collecting data, formulating doctrine, and disseminating doctrine. (16:2)

Collection

Data collection must be an exhaustive process. The framing of CE doctrine should be rooted in AFM 1-1, AFM 1-10, or doctrinal publications by the tactical air forces or joint doctrine publications. Engineering doctrine should build upon these overarching doctrinal works. Other sources could be theater plans, exercise plans or after-action reports, documentation of Prime BEEF and RED HORSE deployments, and the *1979 Joint Contingency Construction Requirements Study* (I and II). *Air Force 2000* also provides an excellent source of strategic vision and doctrine for CE. (18:21)

The greatest storehouse of data comes from the combat experience of our people. Extensive interviews and surveys of those who have CE combat experience (active duty, ARF, or retired) would be helpful.

A review of other nations' experiences, i.e., the Falklands, Arab-Israeli wars, the Soviet Union in Afghanistan, is another source of doctrine. (18:21) A study of the doctrine of enemy forces is imperative to understand how they will fight. Lastly, an extensive literature search is necessary to uncover any missed doctrinal gems. Literature must also be used to update doctrine continually. As this step is concluded, doctrine can be formulated.

Formulation

The data must be distilled into useful statements of doctrine. Key ingredients of CE doctrine must account for fundamental missions across the spectrum of conflict, the enduring principles of force employment, and a lasting professional code of ethics. (18:21) As this process begins, it is necessary to recognize unstated assumptions and to avoid hierarchical pressures as they will create unrealistic doctrine. (16:8) General Holley suggests the following principles: "Compare like experiences to identify common patterns of success, and search for the unlike or dissimilar experiences and ask why?" (16:9) The dialectic approach is an acid test to ensure the best doctrinal statements are developed. A professional military engineering journal article would be a good way to get informal feedback. (16:9;18:31) Formal feedback from conferences, working sessions, MAJCOM reviews, and individual wing review is necessary. (16:12) This input should be used to fine-tune the doctrine before it is disseminated.

Dissemination

Lastly, the doctrine needs to be distributed to CEs. The doctrine must be understood and internalized by every engineer. (18:21) Plans for teaching doctrine must be established as doctrine is being developed. The doctrine must be taught at AFIT short courses and at technical schools. As John Dewey once said, ". . . the real understanding comes not from passive observation but from intensive participation in the creative process." (18:13) The new doctrine will take a great deal of teaching, repetition, and training to become part of the CE mindset. It will be difficult as Liddell Hart said, ". . . the only thing harder than getting a new idea into a military mind is getting the old idea out." (21:16)

Recommendations

Even though CE doctrine is still in the thinking stage, engineers are recognized as warfighters by the operators. (25:11) To incite warfighting fever within the CE officer and NCO corps, more actions can be taken in the areas of training, history of war mindset, and in doctrinal development. Civil engineering commanders must require realistic warfighting training of their people; i.e., RRR using real craters at the home base, expedient methods, buddy care, and others. Additionally, all engineers need to be students of war. Mandatory reading of the greats such as Clausewitz, Sun Tzu, and Hart, as well as research of CE history, is a must with oral reports given to their peers. Weekly warrior seminars over lunch would be a good time to make the reports. The quality of the reports should be commented upon in the individual's performance report (officer and enlisted). A mandatory professional reading program with similar reports is also essential.

All officers and top NCOs must internalize the mission of the engineering unit and the unit they support. Orientation tours and mission briefings of assigned operational units must be given. The TPFDL and wartime OPLAN must be studied with as much intensity as aircrews study single integrated operations plan (SIOP) tasking orders. That is our primary mission and must be fully understood! Exams should similarly be given by the squadron's readiness officer. Utilities target studies of their wartime collocated operating base (COB) or forward operating location (FOL) must also be reviewed so no lost time takes place at the COB or FOL.

Lastly, senior CE leadership should augment its Project Foundation doctrinal development team with ARF members to capture ARF combat experience. During reviews, retired flag and senior grade CE officers should comment on the doctrinal statements. Not to get their view would be ignoring a vast wealth of combat knowledge.

As General Ellis once said:

> Therefore, we should be looking now at a cohesive reinvestment strategy which links established doctrine (basic), human resources, weapons, and basing support into an integrated warfighting machine which can serve us well into the future. (9:10)

I suggest the guiding light for the warfighting machine is civil engineering combat support doctrine.

Conclusion

Civil engineers are warfighters and always have been as proven by our proud history tested under the fire of World War II, Korea, and Viet Nam. The problem is, in periods of peace, we lose the warfighting spirit. We need a CE doctrine to provide a common warfighting thread to our officers and NCOs. We cannot let peacetime corrode our minds. General Ellis put it well:

But we can ill-afford to be complacent. The future belongs to the few who, like our predecessors, have the courage to seize today and shape it into their vision of the future. (9:7)

That vision is driven by sound CE doctrine. To fight and win and keep our air bases survivable, we must have a true warfighting ethic that is instilled by doctrine. But, until the doctrine is published, engineers can take some immediate steps. Be students of war—read the strategy classics and our own history. Understand and internalize the assigned wartime mission and apply warfighting principles to the CE response.

As warriors, we must not look at war as if it will come, but rather when it will come. When it comes, we have to respond smartly in a coordinated manner based on common doctrine. As General Leo Marquez, former DCS/Logistics and Engineering, HQ USAF, once eloquently stated, "When we reach into our quiver of airpower arrows, we must first draw those forged from brains, not mass, money, or more manpower!" (1:2)

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(Col Torgerson wrote this paper while attending AWC.)

1988 Air Force Crew Chief of the Year Award

This year, the Air Force Association (AFA) created a new national award to honor the top crew chief in the Air Force. The winner was Technical Sergeant Timothy P. Carroll, a B-52G crew chief, assigned to the 2nd Bombardment Wing, Barksdale AFB, Louisiana. He was the top choice of ten nominees in the extremely tight competition. General Larry D. Welch, Chief of Staff, USAF, presented the award in September at the 1988 AFA National Convention in Washington DC.

The new award is designed to recognize individual excellence in the critical mission support position of aircraft crew chief. Award eligibility is based on duty position, not Air Force specialty code. Any individual who has been appointed as a dedicated aircraft crew chief is eligible.

Congratulations to TSgt Carroll and all the dedicated crew chiefs out there who contribute significantly to the daily readiness of our mission aircraft.

Major Paul M. Biernacki, HQ USAF/LEYM, AV 227-8164

Early Depot Activation

Traditionally, Interim Contractor Support (ICS) has often been used to provide depot-level maintenance for new weapon systems. This approach is very expensive since the cost of organic support is significantly less than comparable ICS. The budget cuts and fiscal constraints we're now living under make it imperative that we be ready to take non-traditional actions to bring on organic depot capabilities for new systems as quickly as possible.

Earlier organic depot support of our new weapon systems and modifications will enhance our ability to provide combat support through more timely depot maintenance and depot assumption of intermediate requirements on an interim basis. AFLC will provide top priority to intermediate repair during this interim period.

AFLC's new policy is to activate organic depot support, including the purchase of depot-level support equipment, as early as possible in the life-cycle of a weapon system, using innovative practices and smart "work-arounds" as appropriate.

Excerpts from AFLC *Commander's Policy Letter*, 24 June 1988

Contractor-Operated Parts Stores: Is Change Overdue?

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This article challenges the policy that directs the contracting-out of the vehicle parts supply function at Air Force installations. To do that, it analyzes past procedures, decisions, and results relating to Strategic Air Command (SAC) contractor-operated parts stores (COPARS) and government-operated parts stores (GOPARS). To corroborate theory, the article concludes with a postmortem comparison between predicted and actual results from contracting-out procedures on the cost and the efficiency of the vehicle maintenance function at Grand Forks AFB, North Dakota.

The Process

OMB Circular A-76 provides guidelines for determining whether functions should be performed by government employees or by private firms under contract. Within the Air Force, the Director of Manpower and Organization (HQ USAF/PRM) decides the activities that fall into the military nonessential category (noncombat or nonvital) and directs A-76 cost studies to provide data for contracting-out decisions. (16:2-4)

A-76 cost studies compare the government's "in-house" cost of operation to potential contractors' bids for the same service. The A-76 guidelines specify how to compute government costs and what adjustments to make to the contractors' bids for comparison purposes. Figure 1 summarizes the line items of an AF Form 346 for a one-year contract with two renewal options. In this example, the contracting-out decision would be based on total expected costs or savings over three years.

SUMMARY OF AF FORM 346 LINE ITEMS

	Performance Periods			
In-house Performance:	1st	2nd	3rd	Total
1. Personnel Costs				
2. Material and Supply Costs				
3. Other Specifically Attributable Costs				
4. Overhead Costs				
5. Additional Costs				
6. Total In-house Costs				
Contract Performance:				
7. Contract Price				
8. Contract Administration				
9. Additional Costs				
10. One-time Conversion Costs				
11. Gain or Loss on Disposal of Assets				
12. Federal Income Tax (Deduct)				
13. Social Security (OASD) & Savings Plan Costs (Deduct)				
14. Total Contract Costs				
15. Conversion Differential				
16. Total (Lines 14 & 15)				
17. Cost Comparison (Line 16 minus Line 6)				

A positive result on Line 18 supports a decision to accomplish function in-house. A negative report supports the decision to contract.

18. Cost Comparison Decision (check block) Accomplish In-house
Accomplish by Contract

Source: 321SMW/ACC

Figure 1. (2:iii)

General Accounting Office Perspective

The General Accounting Office (GAO) is the federal agency concerned with faulty comparisons as a basis for procurement determinations. GAO reviews are intended to protect arbitrary rejection of contractors' bids by the government rather than as a policing of agency discretion in contracting-out policy. (3:44-45) However, in 1981, GAO conducted two studies that transcended its traditional role in the A-76 process.

First, in April 1981, GAO completed a review of 12 separate DOD contracting decisions and published GAO Report No. PLRD 81-19, "Factors Influencing DoD Decisions to Convert from In-House to Contract Performance." The GAO found a pattern of questionable cost comparison practices that underestimated contract costs and overestimated in-house costs in every decision reviewed. (12:5)

Then, in July 1981, GAO published its other watershed A-76 report, "Military Contractor-Operated Stores Contracts are Unmanageable and Vulnerable to Abuse." The GAO report examined COPARS and contractor-operated civil engineering supply stores (COCESS). COCESS serves a hardware store type function for base civil engineering just as COPARS serves an automobile parts store function for vehicle maintenance. The report's observations and recommendations were:

- GAO believes some aspects of the store contracts are uncontrollable and will continue to result in the government paying higher prices than are available in the commercial market. By awarding exclusive store contracts, the bases are unable to exercise their prerogative to bargain for items readily available in nearby local commercial markets at competitive prices. (14:ii)
- Thus, the A-76 study is an altogether untrustworthy means of determining whether COPARS/COCESS concepts are, in the words of the Acting Assistant Secretary, "more economical" than the direct purchasing concept which this report demonstrates to be an extremely more workable and economical alternative. (14:57)
- . . . We conclude that the implementation of the contractor-operated store concept is unsound, unmanageable, and exposes the Government to potential fraud, waste, and abuse. We believe the contracts should be discontinued. (14:57)
- If the Secretary of Defense determines that an A-76 study is unnecessary (see pp. 56 and 57), he should direct the military services

to discontinue the COPARS and COCESS contracting program with as little disruption of maintenance as possible. As each COPARS and COCESS contract expires, it should not be renewed. (14:iv)

Department of Defense Policy

In his 16 September 1981 letter to GAO, the Principal Deputy Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics) established the DOD COPARS/COCESS Policy that is still in existence today:

> The conduct of OMB Circular A-76 studies has been determined to be necessary. It is believed that the only equitable way to judge the merit and performance of individual stores is through individual cost studies. (8:1)

In May 1982, a Defense Audit Service (DAS) memorandum indicated that the deputy assistant secretary's confidence in A-76 cost studies on contractor-operated stores was more a matter of faith than a matter of fact at the time of his September 1981 letter. Commenting on the GAO report's observations in the memorandum (13) to the Deputy Assistant Secretary of Defense (Logistics and Material Management), DAS states:

> Our review of the internal control systems indicates that most of the significant deficiencies pointed out in the GAO report can be substantially minimized, if not eliminated, provided that recently developed quality assurance and contract administration plans are adopted and effectively executed at all locations.
>
> The comparative cost studies that have been made since 1977 were too few to provide a basis for substantive opinion on the relative efficiency of the operations, i.e., contractor operation versus Government (in-house) operation. None of the Services had completed adequate cost studies to support a conclusion that either contracting-out these types of operations or keeping them in-house is more cost effective. (13:1-2)

In view of the questionable validity of A-76 COPARS/COCESS cost comparisons, it is difficult to understand DOD's unwavering commitment to the process. A skeptical view would be that decisions based on A-76 studies allow the decision makers to take credit for a theoretical reduction in operating costs. The results on paper can be impressive. As shown in Figure 2, DOD claims to have saved an impressive 21% by competing 1,054 operations affecting some 35,500 jobs between 1979 and 1984.

However, it is not always clear that there is any consistent and true substance to claims of A-76 savings. The government's A-76 cost estimate and the contractors' bids are projections of hypothetical costs and efficiencies. While it is easy to take credit for the differences between government estimates and lower projected contractor costs, it may not be accurate. (1:56) Furthermore, bureaucratic claims based on A-76 comparisons do not take into account hidden costs such as the potential of disruptions from contractor defaults and other statistically recurring problems. (12:14)

SAC Policy

Unless DOD specifically allows installation commanders discretionary authority, SAC will continue to instruct its units to retain the COPARS contract operation. (11) The SAC position is based on its transportation directorate's (SAC/LGT) opinion that COPARS ". . . provides better service and is

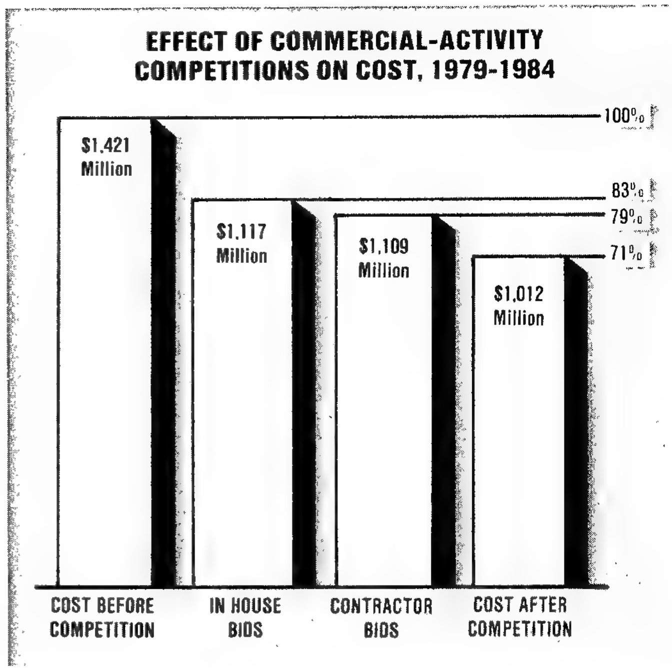

Figure 2. (4:3)

the preferred method . . ." to the in-house GOPARS operation. On the other hand, the SAC contracting (SAC/LGC) and SAC supply (SAC/LGS) directorates take the position that they could support installation commanders on either contractor or in-house operations. (11:PP:2)

COPARS Contract

SAC/LGC's support for an installation commander option in the COPARS/GOPARS issue comes in the wake of significant disagreement with Grand Forks AFB leadership about the standard SAC/LGT COPARS contract format. In March 1985, SAC/LGC directed that the SAC format ". . . will be used for all future COPARS solicitations including those currently 'on the street.' " The letter specified that requests for deviation had to be approved by SAC/LGCC and LGTV. (9:1) Grand Forks AFB personnel wanted changes to the contract that they believed would hold a contractor to a level of performance comparable to an in-house operation and would provide a more accurate basis for an A-76 cost study.

The SAC standard COPARS contract is a unique document. (5:1) It commits the government to buy vehicle parts from a contractor at predetermined percentage discounts from prices listed in current manufacturers' catalogs but which are subject to future change. Prospective bidders develop comparative dollar estimates as bids by individually projecting quantities for different categories of parts and by applying individual industry knowledge to the types and numbers of vehicles in the base fleet. Although contractors submit their bids comprised of a total of estimated prices for each category of parts, the government does not get a commitment as to the actual cost of the contract. In fact, the government does not even know the quantities of parts that each bid represents. (6:Atch 3/1-2)

In January 1987, the Grand Forks AFB contracting division (321SMW/LGC) challenged SAC/LGC concerning the fundamental nature of the SAC standard COPARS contract. (6) Grand Forks AFB personnel believed that the pricing issues in the SAC standard COPARS contract format violated federal

law as prescribed in the Federal Acquisition Regulation (FAR). They claimed that the standard contract was disadvantageous to the government and biased the A-76 cost competition to such a degree that a government operation could not win even in those cases when in-house performance would be preferable to contractor performance. The four major objections raised by Grand Forks AFB personnel were that the contract was:

(1) Erroneously designated a firm-fixed-price contract.

(2) Violated federal acquisition regulations against cost-plus-percentage-of-cost.

(3) Provided an unacceptable basis for a competitive contract award.

(4) Contained a faulty Catalog Pricing/Market Price concept that did not ensure a fair and reasonable price for the government.

In February 1987, SAC/LGC responded to 321SMW/LGC concerns by countering each objection. (10) Subsequently, the 321SMW Deputy Commander for Resource Management (321SMW/RM) forwarded all documents to the AFIT School of Systems and Logistics, Department of Pricing (AFIT/LQS), for "expert opinion" on all objections.

Three AFIT faculty members reviewed the issue and substantially confirmed 321SMW concerns about the standard COPARS contract's effect on contractor performance, its impact on A-76 cost competition, and its compliance with legal guidelines of the FAR. The faculty members observed:

- The contract type is definitely not a firm fixed price contract . . . (5:1) as claimed by SAC/LGC. (6:2)
- Far from simply an issue of semantics, the misclassification of flexibly priced contracts to the category firm fixed price increases risk of excess cost to the Government through fraud, waste, and abuse. (5:2)
- The contract . . . appears to be a form of a cost plus percentage of cost (CPPC) arrangement which . . . guarantees contractor overrecovery of operating expenses as the manufacturers increase catalog prices. (5:1)
- While in an idealistic sense a competitive contract award and fair and reasonable prices might be possible with the SAC format, real world issues make it unlikely that the contract results in price competition or fair and reasonable prices. (5:1,6-8)

Grand Forks AFB Contract Award

Thus, the SAC standard COPARS contract format is a basis for comparing contract bids under the A-76 competition process. Nevertheless, Grand Forks AFB was forced to award a COPARS contract on the basis of A-76 in March 1987. The low bidder was a NAPA auto parts dealer with an estimated annual contract cost of $517,270 compared to an estimated government cost of $562,528. (2) The line item comparisons are shown in Table 1.

IN-HOUSE VS. CONTRACT PERFORMANCE

In-house:	
Personnel Costs	$ 68,231
Material & Supplies	491,616
Other Costs	3,384
Total	$ 563,231
Contract Performance:	
Contract Price	$ 528,366
Federal Income Tax	(11,096)
Total	$ 517,270

Table 1. (2:iii)

Personnel costs were the decisive element in the government's loss. The personnel costs were imposed by the A-76 rules even though in the case of the Grand Forks AFB bid there were no personnel additions. Beyond the personnel issue, an even more serious problem is that there is no certainty as to what the contractor's bid represents. It certainly does not represent a commitment to any specific quantity of parts or to a dollar expense ceiling for the contract. History also would suggest that it does not predict the more economical approach to acquiring vehicle parts.

Rare Opportunity of Grand Forks

Experience at Grand Forks AFB provides a rare opportunity to examine 13 years of virtually clinical data comparing vehicle parts supply by contractors with supply by the government. Since 1975, vehicle parts supply at Grand Forks AFB has alternated about every two years between contractor- and government-operated parts stores. Fortunately, Mr Robert Davis, the Grand Forks AFB transportation maintenance officer, kept detailed vehicle maintenance performance and cost data for both COPARS and GOPARS operations.

Aside from Mr Davis' Grand Forks AFB statistics, relatively little GOPARS data exist within the Air Force. On the other hand, a lot of COPARS information does exist. Most Air Force bases have been buying vehicle maintenance parts exclusively through COPARS for at least the last 10 years except for short interruptions due to contractual problems. Later in this article, the Grand Forks AFB GOPARS and COPARS data will be compared to COPARS data from very similar vehicle maintenance operations at Minot AFB, North Dakota, and Ellsworth AFB, South Dakota.

The impact of COPARS and GOPARS can be measured at least two ways. One measure is to simply show the actual historical costs of vehicle parts under each operation. A second measure is the impact of contractor and government operations on the efficiency of the vehicle maintenance function. The vehicle in-commission (VIC) rate is the basic measure of maintenance efficiency. There are also other measures of efficiency such as mechanic overtime and contract maintenance costs that should be studied to the extent data are available.

Cost of Parts. Grand Forks AFB records show that the installation historically spent less money for vehicle parts under GOPARS than under COPARS. Figure 3 depicts the pattern. Table 2 provides the actual cost figures portrayed in three performance periods for three different Grand Forks contractors from 1976 through 1986. The data show that government operation was between about $62,500 per year and $150,000 per year less expensive during comparable periods. The lower number is skewed by the year that a contractor's bankruptcy caused unusual expenses for the government. Table 3 shows the trend of higher costs under contract operation is continuing with the current contract which is costing the government an average of about $7,800 per month more than the last period of government operation.

A fair concern might be whether the Grand Forks AFB parts cost data portray the total cost of government operation as allegedly does an A-76 comparison. A short synopsis of the Grand Forks AFB GOPARS operation might help in this regard. Personnel costs are often the major A-76 determinant of "total" government cost. (12:20) At Grand Forks AFB, total manpower was the same under GOPARS as under COPARS.

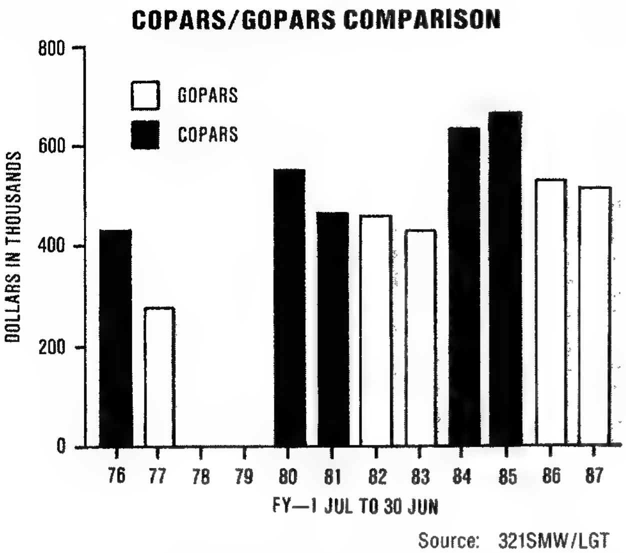

Figure 3.

COST OF VEHICLE PARTS OVER SIMILAR PERIODS

Period*	Type of Procurement	Cost of Parts	COPARS Difference
Mar 76 - Nov 76	Contractor	$428,021	
Mar 77 - Nov 77	Government	$275,408	+$152,613
Jul 79 - Jun 80	Contractor	$548,995	
Jul 80 - Jun 81	Contractor	$464,643**	
Jul 81 - Jun 82	Government	$459,514	
Jul 82 - Jun 83	Government	$428,987	+$ 62,569 AV/YR
Jul 83 - Jun 84	Contractor	$631,984	
Jul 84 - Jun 85	Contractor	$661,987	
Jul 85 - Jun 86	Government	$525,564	+$121,421 AV/YR

* Data not available for Dec 77 - Jun 79
** Contractor default for bankruptcy

Source: Compiled by author from 321SMW/LGTM data

Table 2.

COMPARISON OF MONTHLY PARTS COSTS OF CURRENT COPARS/LAST GOPARS

Month	Cost of Parts GOPARS	Cost of Parts COPARS	Month	COPARS Difference
Apr 86	$44,554	$47,862	Apr 87	+$ 3,308 *
May 86	$49,297	$49,847	May 87	+$ 550 *
Jun 86	$26,195	$54,352	Jun 87	+$28,157
Jul 86	$29,395	$58,820	Jul 87	+$29,425
Aug 86	$36,658	$61,698	Aug 87	+$25,040
Sep 86	$59,296	$58,543	Sep 87	−$ 753 **
Oct 86	$52,032	$50,844	Oct 87	−$ 1,188
Nov 86	$47,289	$47,464	Nov 87	+$ 175
Dec 86	$59,885	$46,000	Dec 87	−$13,885
Jan 87	$49,856		Jan 88	
Feb 87	$49,652		Feb 88	
Mar 87	$54,178		Mar 88	

* Slow parts purchasing because of using up government inventory
** End of fiscal year purchases

Source: Compiled by author from 321SMW/LGTM data

Table 3.

Under GOPARS, Grand Forks AFB trained mechanics in purchasing procedures and detailed them to the parts supply store. The detailed mechanics determined the parts required for bench stock and the items that would be bought as needed through local purchase and base supply. They bought parts the same way commercial repair firms do. They obtained telephone quotes to determine the best combination of availability and price. They placed orders against blanket purchase agreements established by the base contracting office. Parts were normally picked up at the vendors twice a day by transportation or supply personnel and, occasionally, by detailing other personnel such as those on temporary duty restriction.

Under A-76 procedures, the manpower assigned to do the preceding is computed as part of the cost of government operation. However, in reality, there was no additional manpower cost. Rather, there was a reallocation of manpower from one function to another. Furthermore, the reallocation improved the overall operation because vehicle in-commission rates were significantly higher and mechanic overtime significantly lower under GOPARS than under COPARS even though two or three of the mechanics were purchasing parts rather than performing maintenance. As will be addressed later, it took more mechanics to produce less work under COPARS than under GOPARS because contractors were less responsive in supplying parts than was the government supply system at Grand Forks AFB.

The real, total cost of vehicle maintenance was indisputably higher under contract operation. COPARS cost vehicle maintenance more dollars for parts and produced fewer in-commission vehicles with more mechanics performing maintenance. The A-76 procedures distorted manpower data by charging the government for nonexistent manpower increases and by failing to consider the impact of lower in-commission rates and wasted manpower under contractor operation.

Impact on Vehicle Maintenance. Figure 4 graphically depicts the monthly average VIC rates at Grand Forks AFB since 1975. Interestingly, the data show the greatest differences between COPARS and GOPARS in-commission rates during the coldest months which are the hardest on equipment and during the months in which snow equipment is rebuilt in preparation for winter. These are the periods of greatest stress on vehicle maintenance activities.

A closer look at the Grand Forks AFB vehicle data provides additional insight into the higher in-commission rates under GOPARS. Figures 5 and 6 divide the percentages of vehicles out-of-commission into percentages of vehicles awaiting parts, called "vehicles deadlined for parts" (VDP), and vehicles awaiting maintenance, called "vehicles deadlined for maintenance" (VDM). Intuitively, one might expect the difference between government and contract parts suppliers to

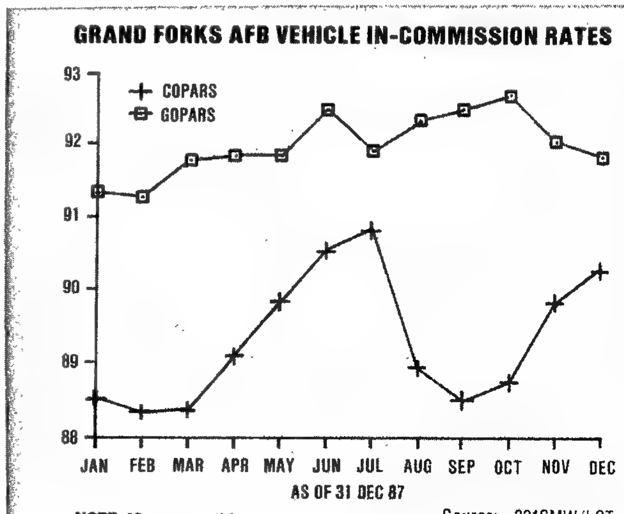

Figure 4.

reflect in VDP. However, the data show that the difference reflects in both VDP and VDM. Furthermore, there is an apparent leverage effect since VDP in both types of operation runs consistently at one-half of the VDM rate.

The VDP and VDM data suggest that the major difference between COPARS and GOPARS is the impact on the efficiency of the maintenance function. Mr Davis' records indicate that although Grand Forks AFB was spending less on parts under GOPARS, the base was buying at least as many parts at a lower unit cost. The difference between GOPARS and COPARS at this location was that GOPARS consistently put more parts into the hands of the mechanics faster than COPARS.

The preceding conclusion is supported by two additional pieces of evidence. First, as stated earlier, there were fewer mechanics working in the maintenance bays under GOPARS because two or three were constantly detailed to the GOPARS store. Therefore, GOPARS achieved better results with fewer people. The second piece of evidence is a little more subtle. Mr Davis accounted for VDP differently under GOPARS than under COPARS. Under GOPARS a vehicle was counted VDP the moment a required part was not available from bench stock. Under COPARS, the contractor was allowed a contractually specified period of time to deliver each part before a vehicle was counted VDP. Therefore, Figures 5 and 6 only begin to illuminate the efficiency issue. The COPARS VDM data actually contain some VDP because parts were not available for some of the VDM time. This is an important point because some have attempted to downplay Grand Forks AFB VIC statistics under GOPARS by focusing only on VDP compared to the VDP of other selected bases. (e.g. 7:1)

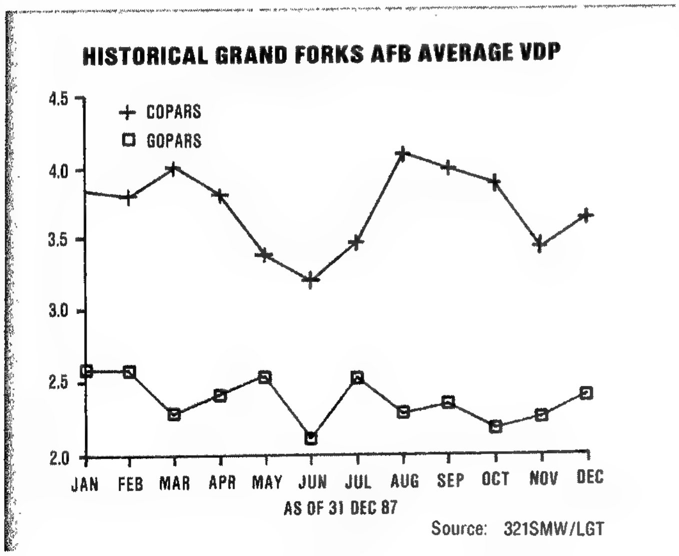

Figure 5.

Value of Out-of-Commission Vehicles. The higher GOPARS in-commission rates are significant in the case of Grand Forks AFB. The vehicle fleet at Grand Forks AFB averages about 1,000 vehicles. GOPARS provided Grand Forks AFB from 11 to 40 more vehicles every day. The average since 1975 has been 28 more vehicles per day under GOPARS than under COPARS.

In 1985, Booz-Allen and Hamilton Inc. completed a study that provides insight into the value of the additional vehicles available under GOPARS. The study, "Project IMAGE" (15), was done for Air Force Civil Engineering at a cost of over half-a-million dollars. Grand Forks AFB was among the bases surveyed by the study. Significant observations in the study are:

- . . . a shortage of General Purpose Vehicles (GPVs) has seriously constrained the time available for its (Base Civil Engineering) crews to perform work. The time lost, termed Transportation Related Nonproductive Time (TRNT), includes:

  Waiting for transportation to/from job sites.

  Dropping off/picking up other crews instead of going directly to the job site.

  Returning to the shop or waiting because there is no vehicle at the job site with a bench stock of frequently used tools and materials.

  Idle crew time because the shortage of GPVs results in crews that are larger than necessary being assigned to jobs. (15:i-iii)

- Our analysis of work force time distribution indicated that 4.4 to 7.4 percent of the average worker's day is Transportation Related Nonproductive Time (TRNT), costing the Air Force $24.8 million annually. (15:ii)
- At most of the bases we surveyed, Civil Engineering personnel were dissatisfied with both transportation maintenance and the operator performed programs. Their dissatisfaction with transportation's vehicle maintenance stems from *perceived* long turn around for vehicles brought in for maintenance. However, our review of maintenance data does not indicate that BCE's GOVs are out-of-commission more than other squadrons'. (15:VI-1)

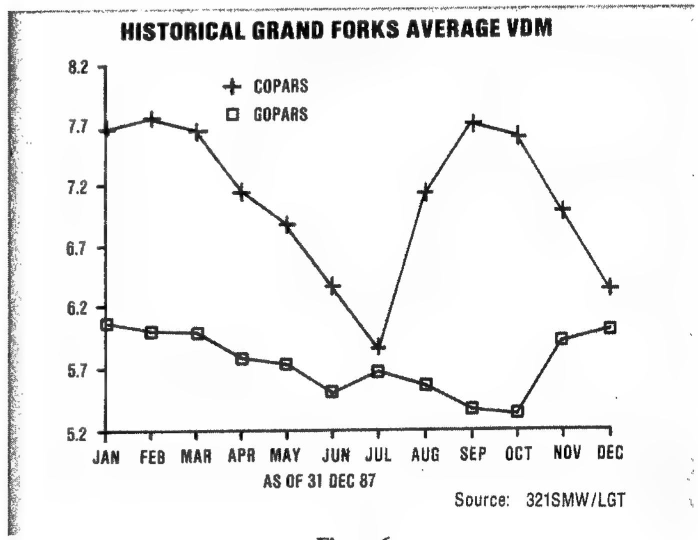

Figure 6.

Comparative Cases of SAC Dual Mission Bases

It has sometimes been alleged that Grand Forks AFB data do not prove the A-76 process faulty because the base has merely had a series of bad contractors over the last 13 years. To gain insight into the accuracy of this claim, Grand Forks data were compared to COPARS data from similar bases. Grand Forks AFB is one of three SAC bases that support both bomb wing and missile wing missions. The other two bases are Minot AFB, North Dakota, and Ellsworth AFB, South Dakota. All three bases have about 1,000 vehicles which accumulate over 8 million miles of travel per year in similar weather. Minot AFB and Ellsworth AFB have been buying parts exclusively through COPARS for several years.

Cost of Vehicle Maintenance Excluding Labor. Figure 7 compares cost data for maintaining the vehicle fleets at the three SAC dual mission bases for FY84 through FY86. The category of "supplies" has been added for completeness since the bases can purchase some parts through either base supply

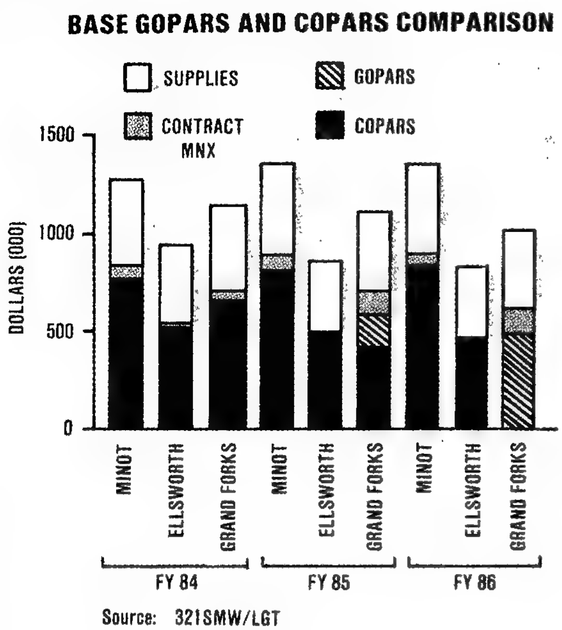

Figure 7.

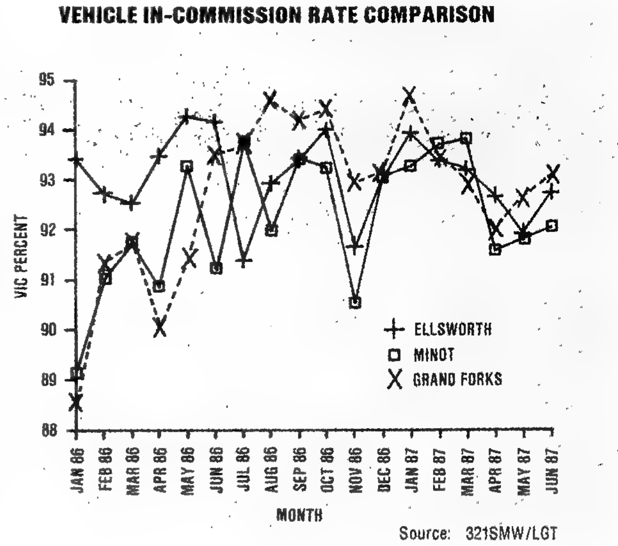

Figure 8.

or COPARS/GOPARS. The data show that Minot AFB's COPARS has been considerably more expensive than Grand Forks AFB's COPARS or GOPARS. On the other hand, Ellsworth AFB has consistently had the most economical operation of the three while using COPARS for parts supply.

A substantial portion of the difference in cost between Ellsworth AFB and Grand Forks AFB is the noticeable absence of contract maintenance by Ellsworth AFB. While it is difficult to equate exactly the Grand Forks AFB and Ellsworth AFB operations and, therefore, to determine precisely the reasons for differences in cost, part of the difference may be because of manpower. Grand Forks AFB and Minot AFB had 115 and 118 vehicle maintenance personnel respectively in FY86. Ellsworth AFB had 131 vehicle maintenance personnel of which 118 were authorized.

A possible explanation for Ellsworth AFB's lower parts and contract maintenance costs could be that the base is doing more maintenance in-house and rebuilding more parts rather than contracting out maintenance and buying new parts through COPARS. While not available for this study, it is likely that if manpower costs were included in the comparison, total maintenance costs, Grand Forks AFB vehicle maintenance costs would likely be considerably less than Ellsworth AFB costs.

Another factor could simply be the result of the quality of service provided by the contractor. Because SAC has been relatively inflexible in allowing individual bases to modify the standard COPARS contract, a major contract performance difference has been the integrity and industriousness of the COPARS store managers working for the contractor. A good store manager will work hard to provide the government economical parts in an expeditious manner. However, there is no contractual incentive for such efficiency.

Impact on Vehicle Maintenance. The recent data shown on Figure 8 suggest the Ellsworth AFB's contractor store manager is providing service comparable to that of the Grand Forks AFB's government manager. On the other hand, Minot AFB's relatively low average in-commission rate suggests that its contractor may not be providing as responsive a service as exists at either Grand Forks AFB or Ellsworth AFB.

Conclusion

All in all, available data show that Grand Forks AFB vehicle maintenance has operated significantly more efficiently under government operation. The data also suggest that Grand Forks AFB might operate significantly cheaper under GOPARS than Minot and Ellsworth AFBs' COPARS operations when manpower costs are considered. Furthermore, the data suggest that the COPARS standard contract allows significant latitude that could make a difference in cost and in vehicle in-commission rates.

A logical conclusion is that GAO COPARS concerns raised over six years ago appear to be valid. The hard evidence supports GAO theory that contractor-operated parts stores may be costing the government hundred of thousands of dollars per contract and adversely affecting the productivity of several functions on every Air Force installation.

It appears that a current review of COPARS may result in the long overdue DOD admission that current policy with regard to the parts supply function must change. However, although the bureaucracy may be ready to admit that past COPARS decisions are grounded on a flawed process, it appears it will continue to insist on imposing COPARS operations and a faulty COPARS contract on SAC installation commanders. It is time to question such judgment.

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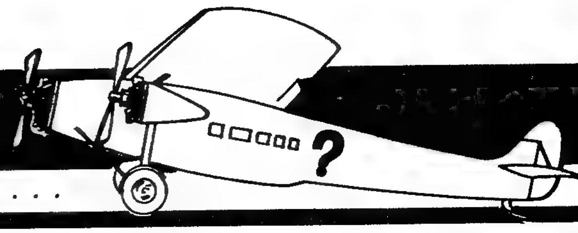
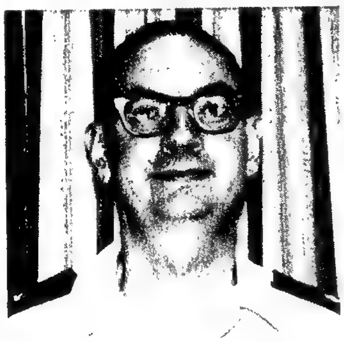


Enquiring Loggies Want to Know . . .

The Logistics Enquirer section of AFJL provides a forum for readers to address important questions to high-level leaders in Air Force logistics. Readers can address questions to specific individuals, or AFJL will select an appropriate respondent. Submitters should identify themselves so as to permit clarification of questions, but we will print only initials if so requested. Our goal is to provide an opportunity for dialogue on crucial issues facing the logistics community. Questions should be broad enough to be meaningful over many months, yet specific enough to be responded to with facts and supportable policy or opinion. *Loggies,* this is your chance to present some tough, challenging questions to our senior AF leaders.



Respondent: Lt Col Randy K. Adams, Logistics Computer Resource Staff Engineer, HQ USAF/LEYYS, Washington DC

Q. It is clear that you consider computer support to be one of the major challenges facing the Air Force today and its combat mission. How much of our current software engineering (all systems not just mission critical software) is supported by contractors (Interim Contractor Support)? What is the projection for future systems and what is the Air Force doing to ensure its own organic capability to support these systems? (Capt John A. Medlin, ASD/SEV, Wright-Patterson AFB, Ohio)

A. I have presented the answer to your question in two parts (Software Management Philosophies and Contractor Software Support Costs) using a point paper format to explain each topic.

SOFTWARE MANAGEMENT PHILOSOPHIES

- Both AFLC and the operating commands have the responsibility to maintain in-house software support capabilities for mission-critical defense systems. All commands are continually improving and expanding their in-house software support capabilities.

- AFLC's goal is to support its software in deployable mission-critical defense systems in-house. However, personnel funding constraints and other factors lead to relying on contractors for some support.

-- Based on an internal AFLC study in 1988, AFLC's mix of in-house vs contractor software workload is 70-30. AFLC has two-thirds of the manpower needed to do in-house software support workloads and one-third of the sustaining engineering funding needed for contractual software support requirements.

-- AFLC is currently studying what workloads should be brought under the depot maintenance umbrella to provide both a peacetime support capability and also a capability to surge to meet wartime requirements. It is likely that the mix of in-house vs contractor workload in AFLC will remain at 70-30 for the foreseeable future.

-- Software updates required during contingencies will be accomplished primarily by our in-house personnel. In support of AFLC's requirements to support rapid reprogramming, the Air Force Wright Aeronautical Laboratory (AFWAL) is doing research to identify the types of software functions in aircraft systems that need to be updated rapidly. The next logical step is to ensure the designs of future systems or modifications accommodate these rapid programming requirements.

- Software in our fixed-site mission-critical defense systems is, and will continue to be, supported by a mix of in-house and contractor personnel.

- Weapon system support systems, such as aircrew training devices are, and will continue to be, supported almost entirely by contractors under contractor logistics support.

- AFLC managed automatic test equipment software is, and will continue to be, supported mostly by our in-house depot maintenance personnel.

- AFLC's management information systems have traditionally been supported mostly by in-house personnel. For our systems in development, the trend will be to rely more on contractors and use our in-house personnel to perform acquisition and support management functions. Each system is evaluated considering available skills and resources to determine whether in-house or contractor support should be used. It should also be noted that independent assessments of the risks associated with relying on contractor support are performed for each of our systems before a support decision is made.

- In February 1988, HQ USAF/SC issued Part 1 of the Air Force Communications-Computer Systems (C-CS) Planning and Architecture Guidance which provides a view of where management of C-CS needs to go.

-- In the future, functional communities, with the assistance of C-CS experts, will be knowledgeable in C-CS technologies and proactive in C-CS planning and application management, and will be involved in development of, and maintenance of, application systems and, if they choose, do the development and maintenance themselves with our help.

-- In the future, C-CS will be designed for greater reliability and maintainability and use open systems architectures to take advantage of both commercial and government off-the-shelf hardware and software products which may be used to satisfy Air Force requirements. These features should reduce development costs and maintenance

requirements, the latter regardless of whether satisfied in-house or by contractor.

CONTRACTOR SOFTWARE SUPPORT COSTS

- In many cases, the "software" portion of contractor-provided system support is not broken out as a separate cost element. Therefore, there is no visibility into the total cost of contractually provided software support.

- It should also be noted that software is part of a system, and software engineering is a subset of systems engineering.

- Contractor provided software support involves significantly more than interim contractor support as implied in the "Logistics Enquirer" question.

- Neither EEICs 585 and 579 (starting in FY88) (interim contractor support) nor EEICs 585 and 578 (starting in FY88) (contractor logistics support) break out software as a separate element of expense.

- EEIC 541 (depot purchased equipment maintenance) has no breakout for software support provided contractually through the depot maintenance industrial fund.

- EEIC 582 (data processing services) also provides some insight into contractual services which can be assumed as being part of the software engineering process. The following information data systems cost information was obtained from AF/SCPB from FY 1988/89 budget program documents. It includes acquisition and support/maintenance costs. Support/maintenance costs are not broken out as separate cost elements.

	FY87	*FY88*	*FY89*
($000)	$580,719	$500,834	$507,955

- EEIC 583 (sustaining engineering) has a breakout for software. The following weapon system software cost information was obtained from the program element monitor in AF/LEXW for EEIC 583 from FY90 USAF Force and Financial Summary documents.

	FY87	*FY88*	*FY89*
($000)	*$64,281*	*$99,070*	*$99,182*

- EEIC 592 (miscellaneous contractual expenses) includes some shredouts within AFLC for software expenses. EEICs 592.TA, 592.TB, 592.TC, and 592.TD are used for software leases, license fees, software modifications and maintenance (other than EEICs 582 and 583), and software acquisition, respectively. EEIC 592.WA is used for field change notices (software updates) for Federal Supply Group 70 commercial off-the-shelf computers. The following costs were obtained from HQ AFLC/ACBO. They are summary costs for EEICs 592.TA, TB, TC, TD, and WA. The large portion (more than 95% of the total) of the costs are for material management software support activities.

	FY87	*FY88*	*FY89*
($000)	$2,844	$4,799	Undetermined

Base Mechanics Create Machine to Save Ozone

A suggestion made by two employees at McClellan AFB, California, has been approved by the Air Force and may help save lives and money.

David Williams, air conditioning and equipment mechanic in the Directorate of Maintenance, turned in a suggestion which would recapture fluorocarbon refrigerants currently being dumped into the atmosphere, contributing to the deterioration of the ozone layer. The ozone layer protects the Earth from the sun's most damaging ultraviolet rays, the main contributor to skin cancer.

In February 1987, Mr. Williams talked to fellow equipment mechanic, Tom Baxter, about reusing fluorocarbon refrigerants. Mr. Baxter agreed that a lot of money was being lost, not to mention the continuing threat to the ozone layer. The pair decided to design and build a working model of a unit that would prevent more than 90 to 95 percent of the hazardous refrigerants from spreading into the atmosphere.

Together, they built a device enabling them to recharge air-conditioning units without harming the environment in the process. Out of old parts, consisting of valves and gauges, they built a portable refrigerant recovery system. The machine, that takes up about two square feet, works on a simple process. The refrigerants are taken from an inoperative unit and condensed into a separate container. Then the inoperative unit can be repaired and recharged. This process would prevent the release of fluorocarbon refrigerants into the atmosphere.

On April 23, 1987, Mr. Williams and Mr. Baxter put their device to the test. Their first operational test was a success and the unit is now being produced by the Air Force patent award program.

Brett Braidman, Office of Public Affairs, McClellan AFB CA

"Shifting national priorities, intense international competition, and a very dangerous world situation are all sending us a clear and unmistakable message: Improve the quality of our processes across the board, or be left behind."

General Alfred G. Hansen
Commander, AFLC

The Beginning of Prime BEEF: An Historical Review

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Introduction

It has been over 20 years since Air Force Civil Engineering (AFCE) Prime Base Engineer Emergency Forces (BEEF) were established in 1964. The value of the Prime BEEF program has been proven over and over again, but how many Air Force members know its historical background? Who initiated it? Why was it initiated? What problems was AFCE facing in 1964? These questions are important because we can learn how to repeat success and avoid mistakes from our past. With the goal of learning in mind, let us look at Prime BEEF's beginnings.

Charter of Project Prime BEEF

Project Prime BEEF (Base Engineer Emergency Forces), a Civil Engineering Manpower Study Group, was the catalyst in the implementation of Prime BEEF. The group consisted primarily of personnel from the Directorate of Civil Engineering, but consultants from the Directorate of Manpower and Organization, the Directorate of Personnel Planning, and the Directorate of Personnel Procurement and Training were on call and participated in discussions. (11:1) In December 1963, this group met to examine this question:

> Is the present Civil Engineer Force properly aligned and is the distribution of this resource adequate to perform the essential real property facility functions in support of the Air Force mission today and tomorrow? (11:3)

Lieutenant Colonel William E. Meredith (later Brigadier General), chairman of the Project BEEF study group, answered this question with a resounding "NO." (8:2) As the study group considered questions of AFCE force alignment and distribution, they were also asked "to create a capability, within existing resources, to respond to emergencies." (11:3)

Before the Project Prime BEEF study group could answer the driving question of alignment, they had to consider the current state of AFCE in view of its increasing direct combat support role. Problems plaguing AFCE at this time included:

(1) No appreciable mobile response capability for contingencies.

(2) Lack of uniformity in the military/civilian mix from base to base.

(3) Improper manpower alignment to meet several pre-1964 crises.

(4) Inadequate career progression for military members. (11: 6-8)

Direct Combat Support Role

As the Project Prime BEEF study suggests, Air Force facility maintenance had changed considerably since World War II. (8:2) The increasing complexity of weapon systems and their growing dependence on sophisticated facilities made adequate Civil Engineering support essential to their operation (8:2). Colonel Meredith describes AFCE's responsibilities:

> CE now has a direct combat support role. Major weapon systems, such as ICBM's [Intercontinental Ballistic Missiles] and the DEW [Distant Early Warning] line, are dependent on Civil Engineering support. The Civil Engineer is intimately involved in limited war operations. Aircraft are more sophisticated, their engines can be ripped apart by poor or improperly maintained runways; therefore, Civil Engineering units must be able to support the aircraft with the type of facilities they require when they are redeployed to meet emergencies. (8:2)

Admittedly, facility maintenance always had been vital to mission success, but it became absolutely critical with the introduction of these increasingly complex and facility dependent weapon systems.

Understanding this facility dependence, the study group concluded that AFCE could not provide adequate support during combat, especially when weapon systems were subject to deployment. (8:2) For example, an F-4 squadron at a continental United States (CONUS) base might be programmed to move to and fight out of a European base. AFCE, at this time, however, was not organized for mobility. Hence, if a flying unit was deployed, there were no plans for a concurrent AFCE deployment. Therefore, any such deployment of AFCE personnel for engineering support would have been difficult and disorganized. This inability provided the primary impetus for Prime BEEF.

Reflecting on Prime BEEF's direct combat support role, Major General Robert H. Curtin, director of AFCE during this time, said that "the Prime BEEF program was initiated to provide responsive, compact TDY Civil Engineering forces of specific military skills for direct support of short-term combat operations. . . ." (4:1) In summary, Prime BEEF was intended to provide AFCE with a means for adequate and timely combat engineering support.

Military/Civilian Manpower Mix

Giving AFCE a direct combat support role had other implications. According to regulation, "military personnel will be used in combat, and direct combat support jobs, and civilians in indirect combat support assignments." (8:2) In other words, if AFCE personnel were needed only for indirect combat requirements, no military personnel were required. AFCE has a direct combat support role given that aircraft cannot take off and land on damaged runways and given that AFCE is responsible for damaged runway/taxiway repair and maintenance. This direct combat role needed to be formalized through Prime BEEF.

Alignment of AFCE's Manpower Resource

Four pre-1964 contingencies proved that AFCE was improperly aligned to respond to emergencies. Lieutenant Colonel Floyd A. Ashdown succinctly describes the difficulties encountered when an unprepared, inadequate base was required to support a sudden, enormous increase in mission:

> The first contingency occurred in Lebanon in 1958. The elected government of Lebanon was in danger of being overthrown. On 15 July 1958, President Eisenhower deployed 5000 US Marines to Lebanon to preserve stability in the region. USAF was to use Adana, Turkey, as a staging base to move people and supplies into Lebanon. The facilities at Adana were not designed to handle this increase in mission. In fact, the base had problems even before the crisis developed. The water supply was inadequate to support the small permanent base population. Limited facilities were available, and POL [petroleum, oil and lubricants] and generator problems were a daily concern of the Base Engineer. In addition, operations and maintenance was accomplished by a new civilian contractor who had only been on the job 15 days when the Lebanon intervention was announced. The contractor's force at Adana was not sized to support the around-the-clock contingency operation that ensued. The Air Force had no system to deploy military engineers to Adana to provide assistance.
>
> As more people arrived at the base and aircraft operations increased, airfield pavements needed repair, base facilities were overcrowded, and utility systems were becoming severely overloaded. Through extraordinary efforts, the maintenance contractor drew skilled technicians from other contract sites to supervise local foreign national laborers temporarily hired to support 24-hour operations. Emergency generators from other bases in the theater were shipped in to provide additional power. Tents provided living accommodations for the personnel overflow.
>
> Water shortages became critical, and Army Engineer assistance was requested. It was only after extreme measures were taken to divert one engineer unit which was in the process of rotating back to the United States that Army assistance was provided. The Army engineers constructed a four-inch pipe water line which helped to alleviate the water supply problem. It is worthy to note that this was the only assistance provided by the Army. Everything else was done by AFCE resources which highlights how dependent the Air Force had become on a civilian contractor. Had the Lebanon crisis required the use of more than one staging base and required increased engineering support at several bases in the theater, AFCE may not have been able to adapt as readily as it did at Adana. (1:35-36)

The second contingency occurred in Berlin in 1961. (10:2) Tension had increased in Berlin from the time of the construction of the Berlin wall (2:850) until 25 July 1961 when President Kennedy called for a buildup of all US services in Europe. (10:2) As a natural consequence of more people, more facilities would be required to support them. (10:2) Brigadier General Oran O. Price, Deputy Chief of Staff of the United States Air Forces in Europe (USAFE) during this period, said:

> Because of the radical upward changes in mission support requirements the bases were critically short of many basic items such as 60-cycle electric power, ammunition storage facilities, alert shelters, maintenance hangars, and shop space. (10:3)

Hence, a facility program was started to support the substantial increase in USAFE forces. (10:2) In some cases, this meant a 1200% increase in facility requirements. (10:2) Most of these new facilities were to be constructed by contract. (10:2) However, on Labor Day, less than two months following President Kennedy's announcement, USAFE was notified that the first units would be arriving the next day. (1:38) Immediate action needed to be taken to ready the facilities for these incoming units. (1:38)

During the Berlin situation, the Air Force requested Army support. Under the provisions of DOD Directive 1315.6, the Army was required to provide military troop construction to the Air Force overseas. (12:190) General Price describes the Army support provided:

> Support by Army Engineer troops was something less than satisfactory. Shortly after this emergency began, only one Army Engineer battalion could be assigned to support the Air Force. This unit, a regular construction battalion, was neither trained nor equipped for airfield work. After assignment of specific tasks, six weeks passed before the battalion had an effective work force operating, and then under a situation in which the Air Force furnished housing, messing, all of the supplies and some of the engineer equipment. (10:4-5)

Evidently, he did not consider Army support very reliable.

According to Colonel Ashdown, the combination of AFCE's experiences in the Lebanon and Berlin crises pointed out a readiness deficiency:

> It was as a direct result of the crises in Lebanon and Berlin that Air Force Civil Engineers began to realize that the engineer force was inadequately postured to fulfill its responsibilities for maintaining combat support and responding to the critical needs during wartime and other contingencies. (1:39)

The next contingency was to develop into a long-term conflict—the crisis in South Vietnam. In 1961, following the increasing threat to the government of South Vietnam by guerilla forces, the United States decided to increase support of South Vietnam. (7:3) This decision caused numerous problems for AFCE. The dilemma was:

> Few CE military personnel were in the command [Pacific Air Forces] and their area of responsibility covered 40% of the earth's surface. PACAF [Pacific Air Forces] was not prepared for the contingency and requested support from the CONUS in the form of CE mobile squadrons. The plan was to locate squadrons on major installations and deploy personnel in flight configurations to support requirements wherever needed. (9:10)

Of course, there were no mobile AFCE squadrons to respond to this request. Consequently, AFCE could not respond.

Finally, in 1962, the Cuban missile crisis occurred:

> For the first time, the inadequacies of the CE force and its inability to respond to contingencies were visible at home. The personnel required to support the crisis, their skills, supervision, and general capabilities were unknown. Actually, the CE forces were obtained for deployment by aircraft going from base to base picking up available personnel at random. (9:11)

This situation did not go unnoticed:

> Shortly after this [the Cuban missile crisis] occurred, General Curtin, Director of Engineering, moved to develop a worldwide civil engineering military contingency capability. The military force would be designed to respond to emergencies, disasters, and limited or general war. (9:11)

The seed for the Project Prime BEEF study group had just been planted.

Manpower Distribution and Career Progression

Other factors contributing to the formation of Prime BEEF were AFCE manpower distribution and career progression.

AFCE Manpower Distribution. Another problem with the existing organizational structure was the poor distribution of manpower resources. (11:6) According to the Project Prime

BEEF study group, some bases did not have enough airmen to continue essential operations adequately under emergency conditions; others had more than required. (11:6) These variations were characteristic within commands as well as between commands. (11:6)

The study group identified several other problems in the use of civil engineering manpower. First, ". . . there was no relationship between the skills identified for military authorizations and the skills needed for direct combat support." (8:4) For example, there were military authorizations for tasks not necessary for direct combat support, such as grass mowing, painting, custodial work, and trash collection. (11:6) This disparity is not surprising since AFCE previously had not been considered a direct combat support operation.

Career Progression. Career progression had also been a problem. (11:6) During the time of the Project Prime BEEF study, skill levels used in airman Air Force specialty codes (AFSC) were related to skill proficiency. The skill level proficiency designator was the fourth digit of the five-digit AFSC number. There were four skill levels distinguished—the 3, 5, 7, and 9 skill levels. For example, in the missile facilities maintenance career progression ladder, an airman in missile facilities maintenance at the 3 skill level was considered an "apprentice missile facilities specialist." (8:5) A 5-skill-level missile facilities maintenance airman was considered a "missile facilities specialist." (8:5) A 7-skill-level missile facilities maintenance airman was considered a "missile facilities technician." (8:5) Last, a 9-skill-level missile facilities maintenance airman was considered a "missile facilities superintendent." (8:5)

In AFCE, however, it was not always possible to attain a 7 or 9 skill level. In five AFCE career specialties, for example, the airmen could advance no higher than a 5 level. (11:6) In other words, they were in dead-end career fields.

The proposed Prime BEEF reorganization would eliminate these dead-end career fields by providing the opportunity for each airman to reach a 9 skill level, regardless of his/her entry level specialty. (8:4) This was accomplished by establishing 21 career ladders which fed into the following ten 9-level "supergrade" slots: (1) missile facilities superintendent, (2) electrical superintendent, (3) electrical power production superintendent, (4) mechanical superintendent, (5) pavements superintendent, (6) structural superintendent, (7) site development superintendent, (8) work control superintendent, (9) sanitation superintendent, and (10) fire protection superintendent. (8:4-5)

For example, the career ladders for both the pavements maintenance and construction equipment operators fed into the one pavements superintendent "supergrade" slot. (8:4-5)

As expected, if higher skill levels were required, so were commensurate higher grade levels. In short, the Prime BEEF organizational structure called for an increase in higher grades and a decrease in lower grades. The Military Airlift Command's (MAC) history provides a snapshot of MAC AFCE manning on 1 July 1965 (Table 1).

The drastic changes mandated by Prime BEEF could not be immediately reflected in Civil Engineering's Unit Manning Document (UMD) because some positions required military-to-civilian conversion and vice versa. (6:509) In effecting the conversions, civilian reduction-in-force actions were not authorized. (6:510) Therefore, some positions could not be converted until they became vacant by attrition. (6:510)

MAC AFCE MANNING, JULY 1965 (6:508)

Prime BEEF Airman Grade	CE Unit Manning Document Requirement	Authorization
E-8 and E-9	55	11
E-7	108	38
E-6	142	90
E-5	275	342
E-4	350	314
E-2 and E-3	419	971
TOTALS	1,349	1,766

Table 1.

Across the Air Force, the increases in AFCE grades E-6 through E-9 from 1965 to 1970 are shown in Table 2.

AFCE GRADES E-6 THROUGH E-9, 1965-1970 (5:15)

Grade	1965	1970
E-6	2,163	3,118
E-7	913	1,493
E-8	307	586
E-9	70	164
TOTALS	3,453	5,361

Table 2.

These gains were attributed directly to the implementation of Prime BEEF. (5:15)

Besides providing additional skill levels and grades, the prime BEEF structure could improve promotion possibilities by providing competent AFCE airmen with an opportunity to display their talents in more visible and responsible positions. (3:3). Of course, the increased responsibilities would also identify those unfit for promotion. Note the following comments:

> The grade structure called for in the program [Prime BEEF] recognizes the necessity for having experienced and qualified military supervisors and technicians at all levels of responsibility. In a sense, we are demanding more from our civil engineering enlisted force and in return offering them more opportunity to exercise authority, initiative and skills. (3:2)

Whether or not this enhanced visibility was a fringe benefit of Prime BEEF depended on the individual airman's competence.

Rationale Behind Prime BEEF

The increase in weapon systems facility dependence, the increase of contingencies worldwide, and the inability of the then current AFCE structure to respond quickly and adequately to contingencies all led to Prime BEEF. Consequently, the Project Prime BEEF study group reorganized AFCE to ensure quick, effective response to contingencies.

The rationale behind implementing Prime BEEF is best summarized by General Curtin:

> It [Prime BEEF] is an Air Force-wide program to assure that our total Civil Engineering force is in proper balance and can provide responsible support to all short-term emergencies as well as meet our normal day-to-day needs. (4:1)

Continued on page 32

Power Conditioning and Continuation Interfacing Equipment (PCCIE) Procurement

The Air Force Logistics Command has begun an extensive PCCIE management program. The first requirements contract for PCCIE uninterruptible power supply (UPS) equipment was awarded in June 1988 by Sacramento ALC. A second requirements contract to cover power conditioning equipment is soon to be awarded. Agencies needing PCCIE to support old electronics equipment or to replace current PCCIE should use the standard base supply system to identify their requirements to the Sacramento item manager. If new system procurements require PCCIE, the procurement should be budgeted for as part of the new system requirement. (Maj Roy B. Gaskill, AF/LEXP, AUTOVON 225-7740)

New AFR 400-24

At the 1987 Worldwide WRM Conference, the Logistics Plans Community unanimously supported an effort to rewrite AFR 400-24, *War Reserve Materiel (WRM) Policy*. In January - February 1988, a rewrite conference was held at the Pentagon and the regulation was scrubbed from beginning to end. This draft was then forwarded to all MAJCOM LGX staffs for their comments. The collective effort of these Log Planners produced a second draft which was released for final coordination in August 1988. There are several changes in the draft. The planners established separate chapters for medical, subsistence, bare base, and individual clothing and equipment WRM policy. They also made significant changes in peacetime use policy which delegated responsibility to the MAJCOMs and the units. In addition, they rewrote guidance to provide for clearer classification instructions. The ultimate goal of this revision was to establish clear policy for WRM management, yet still give MAJCOMs the flexibility to tailor their WRM programs as necessary for effective mission support. We have set a target date of 1 January 1989 for publication of the new AFR 400-24. (AF/LEXX, Capt Bill Neer, AUTOVON 225-2175)

Tactical Shelters

Within the next five years, the Air Force expects to have an inventory of 1700 tactical shelters, while the DOD will have nearly 10,000 overall. The shelters solve many facility related problems, but their size creates several challenges to the Defense Transportation System. Shelter users must identify the transportation system to move the shelter from home base, through the airlift or sealift system, and onto the ground at the deployment location. If users do not know how the shelter will transfer through this system, their deployment scheme is incomplete. All users are responsible for part of the movement. The Military Airlift Command, Military Traffic Management Command, Military Sealift Command, and overseas commanders share the remaining responsibility, but they CANNOT do their job unless users identify movement requirements. (Lt Col Seale, AF/LETTC, AUTOVON 227-4742)

Technology Transition Plan for Artificial Intelligence

The first Air Force Logistics and Engineering Technology Transition Plan for artificial intelligence has been developed and coordinated by the major commands (MAJCOM), and is currently in revision, incorporating salient MAJCOM comments. Many of these comments focused upon training and the need to become more aware of artificial intelligence and other new technologies. Interested parties should seriously consider training classes provided by the Air Force Institute of Technology (AFIT), local universities, and commercial vendors in order to become more conversant on how the artificial intelligence technology can be successfully applied in Air Force Logistics. The Air Staff has worked closely with our colleagues in personnel to ensure this type of technology training can be properly applied and used. The revised AI technology transition plan should be ready for final publication in early fall 1988. (Maj Joe Michels, AF/LEXY, AUTOVON 225-6756)

New Design Standards for Aircraft Refueling Facilities

Modern aircraft refueling facilities have microprocessors for controlling fuel dispensing and are thus susceptible to high altitude electromagnetic pulse (HEMP) conditions. The Air Force Weapons Lab has recommended hardening power and motor switching centers where microprocessors may reside. However, it is not necessary to harden the entire refueling facility because the equipment is generally robust. This represents a significant change to normal HEMP protection in that equipment is hardened but not the facility. Special cooling techniques for the equipment will have to be developed. These new requirements are being addressed in an Engineering Technical Letter and the new design standards for aircraft refueling facilities. (Mr R. S. Fernandez or Mr Ed Lee, AF/LEEEU, AUTOVON 297-4083)

WRM Subsistence Prepositioning Program for Europe

Due to lack of warehouse space within the European theater, only operational rations Meal Ready-to-Eat (MRE) or Meal Flight Feeding (MFF) are stored at main operating bases (MOBs). HQ AFCOMS plans to maintain sufficient MREs/MFFs in-theater to cover operational requirements for 5 days. Additionally, to eliminate the WRM shortfall, HQ AFCOMS has negotiated a memorandum of understanding (MOU) with the Defense Logistics Agency (DLA) to preposition subsistence stocks (consisting of 89 semiperishable "B" ration items) at Defense Personnel Support Center (DPSC) depots in Europe and CONUS. DLA has capitalized $531,000 of "B" ration items already delivered to Europe and will continue capitalizing WRM subsistence upon receipt, plus store and manage those Air Force WRM assets. HQ USAFE,

as the user, is responsible for movement of those subsistence assets that will be stored in CONUS to their intended destination. Subsistence stocks will not move unless movement requirements are identified through the transportation channels. We must fill this gap to ensure our troops have the food needed during wartime. (Mr Chuck Ervin, HQ AFCOMS/DOS, AUTOVON 945-6414)

Civil Engineering Doctrine - Project Foundation

The Air Force now has doctrine describing the enduring principles of combat support and the combat support process (AFM 1-10, *Combat Support Doctrine*). The next step is to develop doctrine for each functional area within combat support. We are doing that for civil engineering through Project Foundation. We are developing doctrine that states the enduring truths regarding manning, organizing, equipping, training, and employing civil engineers as an integral part of combat support. We recently convened a Blue Ribbon Panel of senior active duty and retired civil engineers and combat support officers to capture from their experiences doctrinal precepts for civil engineers. A Doctrine Working Group will use these precepts, along with other data collected through Project Foundation, to draft the civil engineering doctrine manual. This manual will be in two volumes. Volume I will be concise doctrinal statements describing the foundations of civil engineering support to the Air Force mission. Volume II will be a greatly expanded discussion of the precepts in Volume I. It will capture the rationale and support behind particular precepts, making it an excellent reference manual to aid in the institutionalization and updating of the doctrine. (Maj Hicks, AF/LEEX, AUTOVON 225-7744)

Merging of Services and Food Services Enlisted Career Fields

Effective 30 April 1988, the Services and Food Service enlisted career fields merged into a single Air Force specialty code (AFSC). Merging the career fields will create a force comprised of well-rounded services technicians familiar with all aspects of the services business who can perform wherever the need is greatest. The merger decreases a critical services wartime shortfall and improves wartime capability. It also allows the services manager greater flexibility to assign the best people to the most challenging jobs, gives the enlisted force more versatility, and reduces unfavorable rotation index of senior NCOs. (Lt Col Tucker, USAF/LEEH, AUTOVON 225-0466)

WANTED: Articles by Enlisted Personnel (Why We Don't Write)

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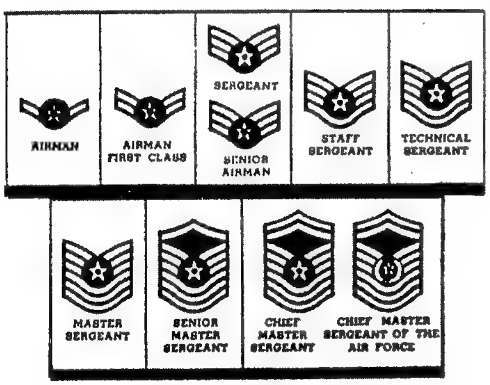

One area where enlisted involvement is obviously absent is participation in the mass communication process. Trade journals regularly feature stunning articles written by officers on enlisted matters, but only occasionally do articles on provocative enlisted issues appear courtesy of our own. Why?

It could be that in our profession, and particularly in view of the enlisted management structure, a shortage of ideal media sources and inadequate solicitation may have contributed to a sense of idea suppression. Let me assure you, that to express one's idea in any media (public or private) is to chance the scrutiny of professional criticism. Yet, I can presently think of no one, officer or enlisted/male or female, who has suffered an excruciating demise for having done so. Perhaps, we have acquired a reluctance of public self-expression for fear of private ridicule at the hands of our peers. But is not conversation a form of public expression?

I continue to encounter extremely gifted airmen, NCOs, and senior NCOs. Many are college educated and a significant number possess college degrees. Ask people who know of them and they quickly point out that these individuals are highly regarded, uniquely decorated, and among the very best in their respective fields. They are in the words of their superiors, "the backbone" of the organization. They are distinguished graduates of technical training schools and professional military education schools. These same individuals were selected outstanding airman, NCO, Senior NCO, or First Sergeant of the Year for their unit or command. And then there were twelve—the Air Force's Outstanding Twelve.

Any notion that these exemplary people are illiterate, have nothing to say, have no good ideas, or are incapable of communicating their ideas to the masses is absurd and dated. We must act quickly to change these negative perceptions.

So to those that would, but do not, please write. Let your mind be read.

Continued from page 17

9. Letter, SAC Acting Deputy Director of Contracting (SAC/LGCC/LGTV), Major Carl E. Kriley, to all unit contracting divisions and transportation squadrons (IG/LGC/LGT), subject: SAC Standard COPARS Format, 22 March 1985.
10. Letter, Deputy Director of Contracting, DCS Logistics (SAC/LGCC), Daniel M. Carr, to 321 SMW Contracting Division (321SMW/LGC), subject: Contract F32605-87-DS001, 19 February 1987.
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12. Mayer, Andrew. *Contracting Out: Some Basic Policy Questions for the DOD and Other Government Agencies*, Report No. 83-142F, Congressional Research Service, 19 September 1983.
13. Memorandum for Deputy Assistant Secretary of Defense (Logistics and Material Management), subject: Report on the Review of the Status of Contractor-Operated Civil Engineer Supply Store (COCESS) and Contractor-Operated Parts Store (COPARS) Programs (Project 2SS-065), 20 May 1982.
14. *Military Contractor-Operated Stores' Contracts Are Unmanageable and Vulnerable to Abuse*, A Report to the Congress of the United States by the Comptroller General, General Accounting Office of the United States, Report No. MASAD-81-27, 8 July 1981.
15. *Project Image*, Booz-Allen & Hamilton Inc. Report No. 09006-130-001, "Base Civil Engineering General Purpose Vehicle Requirements Study," U.S. Air Force Engineering Services Center, August 1985.
16. Schaub, Kenneth L., Major, USAF. *So You're a Candidate for Contracting Out: Plain Talk for the Base Level Manager*, Air Command and Staff College research report no. 85-2305, Air University, Maxwell AFB AL, April 1985, p. 60.

Scheduling Tactical Aircrews to Meet Flying Requirements

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Introduction

Basically, all US Air Force tactical flying squadrons are self-sufficient and have the same structure. Assigned enlisted personnel accomplish administrative and life support duties, and a nonflying officer functions as the squadron commander's executive officer. Aircrew members manage all remaining squadron tasks which include scheduling, training, and mission planning. It is common for a crewman to work 10 or more hours per day to meet the demands of flying and nonflying duties.

Although the techniques and principles discussed are applicable to all tactical flying units, the research activities described focused on the 91st Tactical Reconnaissance Squadron (TRS). The squadron is currently flying 18 RF-4C reconnaissance aircraft, 6 of which are equipped with the advanced ARN-101 Digital Modular Avionics System (DMAS). Each RF-4C is manned by an aircrew of two individuals, a pilot and a weapon systems officer (WSO). The WSO assists the pilot in handling the numerous systems aboard the aircraft. Because the RF-4C requires both crewmen to perform specific duties which assist and complement each other, operational efficiency is maximized by designating specific pilot/WSO teams (*crewed* pilot/WSO pairs) who should be scheduled to fly training missions together as much as possible. For this reason, a crewed pilot and WSO will usually have similar levels of experience and capability.

During the time that this research was conducted, there were about 27 pilots and 25 WSOs flying for the 91st TRS. Their capabilities ranged from newly assigned and inexperienced crewmen, still training to attain full "mission ready" status, to highly experienced individuals capable of performing every possible mission.

Operational Procedures

The 91st TRS wing flight management section provides administrative support and uses a Sperry minicomputer to keep records of completed flying hours, completed and required training, and *flying currencies* for each crewman; i.e., whether the allowed maximum amount of time between specific missions has been exceeded. (If the maximum time has been exceeded, special supervision will be required on subsequent training missions where the flying currency has not been maintained.)

Training requirements on the seven different types of missions flown by the 91st TRS are set at the wing headquarters level and above. The number of missions required by the 91st TRS is given in Table 1. The number of each type of mission required for each individual in a 6-month training period depends both upon experience class ("experienced" or "inexperienced") and proficiency level (A, B, or C). To help gain proficiency, inexperienced crewmen require more missions than experienced crewmen and less proficient crewmen fly more missions than their more proficient counterparts. During each mission, aircrews are responsible for accomplishing a wide variety of "training events." More than one event may be accomplished per mission. It is assumed that if a crewman flies the minimum number of each mission type, he has been given ample opportunity to accomplish all required events. Although the level of training activity can be as high as 40 missions per day, the squadron flies an average of 16 missions per day.

MISSION REQUIREMENTS PER 6 MONTHS

	PROFICIENCY LEVEL		
TYPE MISSION	A	B	C
DAY RECONNAISSANCE	14/11	20/16	25/20
DAY RADAR	14/10	20/15	24/17
NIGHT RADAR	4/3	6/4	9/7
AIR COMBAT TRAINING	6/6	6/6	8/8
ADVANCED HANDLING (WITH IP)	1/1	1/1	1/1
DEFENSIVE MANEUVERING	2/2	2/2	2/2
INSTRUMENT	2/0	2/0	2/0
TOTAL GRADUATED COMBAT CAPABILITY MISSIONS	38/30	52/41	66/52
TOTAL MISSIONS	52/42	68/55	85/68

KEY: (No. Missions for Inexperienced/Experienced)

Table 1: Mission Requirements for the 91st TRS.

One of the most difficult and time-consuming nonflying duties for crewmen is that of being a squadron scheduler. Depending on the size and complexity of the squadron, the scheduling section normally consists of between four and eight individuals. After coordination with maintenance and headquarters, the schedulers produce weekly flying schedules. A central "wing scheduler" is responsible for coordinating and publishing the schedules for all squadrons (normally three or four) in the wing. In addition to flight training missions, a squadron schedule includes the manning of many other flying related duties such as Supervisor of Flying, Squadron Supervisor, and Wing Stand-up.

An example of a complete daily schedule is given in Figure 1. Note that each day's total flying hour allocation, given in the first four columns of the *FLYING SCHEDULE*, is produced in coordination with headquarters, the squadron maintenance units, and the squadron commander. Hence, the squadron scheduler has *no control* over this part of the schedule and must view missions in the total flying hour allocation as a set

SAMPLE SCHEDULE (25 NOV 86)
FLYING SCHEDULE:

BRIEFING	TAKEOFF	LANDING	TYPE	PILOT	WSO
1030	1320	1450	DM	RUPP	ALZLER
1030	1320	1450	DM	BARRIS	KURRAN
1030	1330	1500	DR	CLIFF	KOOP
1030	1330	1500	DR	HERMAN	CONNER
1030	1340	1510	DV	ELLIS	DISHNER
1030	1340	1510	DV	RALLS	DALL
1030	1350	1520	DR	KRICK	HILLIS
1030	1350	1520	DR	DILLER	SUTTER
1030	1400	1530	DV	FRICH	ROGERS
1500	1800	2000	NAAR	STUBBS	MORRIS
1500	1800	2000	NAAR	KOLLAR	HALSTON
1500	1800	2000	NAAR	FICH	MORLEY
1500	1800	2000	NAAR	SWISHER	BILLMAN
1500	1810	1940	NR	WICKER	MACHER
1500	1810	1940	NR	BOURNE	GALWAY
1500	1820	1950	NR	GIPPER	DILLY

ADDITIONAL REQUIREMENTS:

0730-0830	SCHEDULING MEETING; RALLS
0730-1400	CERTIFICATION PREPARATION; MANLEY, DILLY
0800-1500	CERTIFICATION PREPARATION; WICKER, GROOD, HARLEY, COKER
0930-1030	FUNCTIONAL AREA CHIEFS MEETING; RALLS, HERTEL, CONNER, HALSTON, GOODMAN
1030-1500	SUPERVISOR; HOWLEY
1255-1755	SUPERVISOR OF FLYING; TALLEY
1300-1530	CERTIFICATION; BOWKER
1400-1600	PRACTICE CERTIFICATION; HOWLEY, FICH, BILLMAN, KOLLAR
1500-2030	SUPERVISOR; BOWKER
1600-1700	FLYING SAFETY MEETING; BOWKER, FORD, BILLMAN, GIPPER
1630-1745	PRACTICE CERTIFICATION; HERTEL, CONNER, DALL, HOWLEY

KEY FOR TYPE OF MISSION:
DM = DEFENSIVE MANEUVERS
DR = DAY RADAR
DV = DAY VISUAL
NAAR = NIGHT AIR REFUELING
NR = NIGHT RADAR

Figure 1: A Typical One-Day Schedule.

of associated *jobs* to which appropriate available personnel *must* be assigned. (Note that there are two jobs associated with each mission, one filled by a pilot and one filled by a WSO.)

At 91st TRS, scheduling has been done entirely by hand with the exception that the computerized training requirement printouts provided by wing headquarters were referenced during the scheduling process. Each week, one of the *five* schedulers performed no (or very limited) flying duties to allow him time to work on the schedule and to provide some measure of continuity for scheduling decisions.

Under that practice, the process of building a good weekly schedule normally starts about Wednesday of the prior week. Central to this activity are the flight commanders who oversee approximately 8 to 15 officers and are responsible for ensuring flight scheduling needs are met. All requests for time off, meetings, appointments, and similar commitments are made through the flight commanders who inform the schedulers of the availability and requirements of each individual in their flight. In addition, the flight commander monitors the training requirements and flying currencies. Final responsibility for the squadron rests with the Squadron Commander and Operations Officer.

There are many factors which increase the difficulties encountered by the squadron scheduling section. First, since no individual may work more than 12 hours per day, it is often difficult to schedule crewed pairs in the same aircraft and still cover all flying and nonflying duties. The formed crew roster (with fictitious names), i.e., the crewed pilot/WSO pairs, for the 91st TRS is given in Table 2. Note that the 91st TRS has assigned a primary and alternate WSO to each pilot. In effect, each pilot is crewed with two WSOs, but the primary WSO is preferred.

FORMED CREW ROSTER (AUG-DEC 86)

	PILOT	PRIMARY WSO	ALTERNATE WSO
1. A Flight:			
	KOLLAR	BRICKER	HALSTON
	GOODMAN	BILLMAN	SHIVELY
	SHORT	BICHLER	BRICKER
	DODGE	HALSTON	BICHLER
	DAVIDON	SHIVELY	BILLMAN
2. B Flight:	PILOT	PRIMARY WSO	ALTERNATE WSO
	ELLIS	HOCKLEY	BOXER
	DILLER	SUTTER	DALL
	RALLS	DALL	SMATHERS
	MARSTON	SMATHERS	SUTTER
	SKOOT	BOXER	BATCHER
	GALWAY	BATCHER	HOCKLEY
3. C Flight:	PILOT	PRIMARY WSO	ALTERNATE WSO
	GIPPER	DILLY	KOOP
	SWISHER	TALLEY	ALZLER
	SCHMIDT	ALZLER	COKER
	CLIFF	CONNER	TALLEY
	FRICH	COKER	CONNER
	FICH	KOOP	DILLY
4. D Flight:	PILOT	PRIMARY WSO	ALTERNATE WSO
	HERMAN	HERTEL	MACHER
	GRITT	CATCHER	HILLIS
	STUBBS	ROGERS	BONO
	FREZEL	MORRIS	ROGERS
	WICKER	MACHER	CATCHER
	SCHRIFT	BONO	HERTEL
	BLOND	HILLIS	MORRIS

5. Uncrewed Individuals:
ROLLINGS, COL FLIND, COL RANK, SHERILL, BOWKER, HOWLEY, COL EBBING, and MORLEY

Table 2: Formed Crew Roster for the 91st TRS.

A second factor adding difficulty to the scheduling task is that the squadron members have varying levels of qualifications. For example, a squadron may be capable of employing several different special munitions, normal day air-to-ground ordnance, night air-to-ground ordnance, and air-to-air weapons. Each type of mission has a specific qualification and level of proficiency required. A given crewman may possess one or more of over 20 different qualifications. Before a crewman can be assigned to a specific task, the scheduler must ensure he is qualified to perform that mission. An excerpt from a typical list of qualifications for members of a tactical flying squadron is presented in Figures 2(a) and 2(b).

A third factor compounding the squadron scheduler's task is the large number of flying and nonflying jobs coupled with the limited number of personnel. Since aircrew members usually have two or more specific assignments to perform in a day, the daily schedule can become a highly dependent structure with very little flexibility. Often, if one person becomes sick or unavailable, the entire schedule starts to fracture, requiring schedulers and squadron supervisors to use sound judgment as to the best way to safely reassign personnel to the required flying jobs.

The objective of this research was to develop a computerized scheduling system to assist tactical flying squadron schedulers in the 91st TRS and to do so in such a way

PILOT QUALIFICATIONS (8 DEC 86)

PILOT NAME	EXP	TNG PHS	GCC LVL	WX CAT	RSO	SOF	SEF	FLD	INS	INF	AR1	DM	DDM	TER	LA3	LA1	IDM	SCR	IDD	FCF	LAS
BARRIS, J.	E	MR	B	A		T		T			T	T			T						
BOWKER, W.	E	MR	A	A		B		X	X	X	X	X		X	X						X
CLIFF, C.	N	MR	B	A	X						X	X			X						
⋮																					
SCHMIDT, P.	E	MR	B	A	X		X	X	X	X	X	X	X	X	T		X		X		
STUBBS, D.	E	MR	B	B	T			X			T	X	X		F	X					
SWISHER, D.	N	MR	B	D	X						B	X			X						
WICKER, D.	N	MR	B	C	X						B	X			T						

Figure 2(a): An Example List of Pilot Qualifications.

WSO QUALIFICATIONS (8 DEC 86)

PILOT NAME	EXP	TNG PHS	GCC LVL	WX CAT	RSO	SOF	SEF	FLD	INS	INF	AR1	DM	DDM	TER	LA3	LA1	IDM	SCR	IDD	FCF	LAS
ALZLER, D.	E	MR	B		X		X		X	X	I	X	X	X	F	T				X	
BICHLER, R.	E	MR	B		X				X	X	X	X	X	X	F					X	
BOCKLER, B.	N	MQT																			
⋮																					
SHERILL, M.	E	MS				B					X	X		X	F						
SMATHERS, A.	N	MR	B		X						T	X			T						
TALLEY, L.	E	MR	B		X	B					X	X	X	X	F						

Figure 2(b): An Example List of Weapon Systems Officers Qualifications.

Key:
For all qualifications (X = qualified, T = in training)

EXP	= Experience Level (Experienced or Non-experienced)	INF	= Flight Instructor
TNG PHS	= Training Phase (Mission Ready, Mission Support, or Mission Qualification Training)	AR1	= ARN 101 (basic level only)
GCC LVL	= Graduated Combat Capability Level (A, B, or C)	DM	= Defensive Maneuvers
WX CAT	= Weather Category (A, B, C, or D)	DDM	= Dissimilar Defensive Maneuvers
RSO	= Runway Supervisor Officer	TER	= Terec System
SOF	= Supervisor of Flying (B = Bergstrom qualified)	LA3	= Fly low level at 300 feet
SEF	= Standardization & Evaluation Flight Examiner	LA1	= Fly low level at 100 feet
FLD	= Flight Lead (2 = two-ship flight lead)	IDM	= Instructor in Defensive Maneuvering
INS	= Simulator Instructor	SCR	= SCAR Capable
		IDD	= Instructor in Dissimilar Defensive Maneuvering
		FCF	= Function Check Flight Aircrew
		LAS	= Low Altitude Supervisor

that the system could be adapted to assist in the scheduling activities of other tactical squadrons of the US Air Force and in other military and civilian applications with similar requirements. Desired goals for the schedules generated by the system were to fulfill all 6-month training period requirements as quickly as possible, maximize the number of missions flown with crewed pilot/WSO teams, minimize the number of unrequired missions flown, and distribute the flying jobs among the crewmen as evenly as possible. Of course, these goals had to be achieved within the restrictions of available equipment and personnel.

A Review of Associated Research

There have been numerous applications of operations research techniques to manpower scheduling. These techniques include, but are not limited to, integer programming, simulation, networks, and heuristics. In this section, we briefly review three related scheduling problems and proposed solution algorithms.

The *nurse scheduling problem* (NSP) bears many similarities to the *reconnaissance aircrew scheduling problem* (RASP), previously introduced. Like the RASP, each job in the NSP has a specific level of competency required. The objective function is usually a combination of the best supervision for each hospital ward, nurse preferences for a specific work schedule, and monetary costs based on overtime and additional hirings. Warner (11) modeled the NSP as a large multiple-choice programming problem whose objective function quantified nurse preferences concerning length of work stretches, rotation patterns, and requests for days off. The constraints provided for minimum numbers of personnel of each class to be assigned to each shift of a 6-week scheduling period. Smith and Wiggins (10) described a computer-based heuristic which considered a complicated set of constraints when generating monthly shift schedules. Miller *et al.* (7) solved the NSP by using a cyclic coordinate descent algorithm to minimize an objective function that balances staffing coverage and nurse preferences. Musa and Saxena (8) used a single-phase goal programming technique to schedule nurses in one unit of a hospital. Arthur and Ravindran (1) proposed a two-phase heuristic solution. The inclusion of multiple objectives or goals ranked according to the preferences of the decision maker was permitted while the heuristic made specific shift assignments.

There are several differences between the NSP and the RASP. The NSP works on periods of 4 to 8 weeks, while the RASP looks at a 1-week period broken down into daily schedules. The RASP associates numerous skills with each individual, thus creating a more sophisticated feasibility region than for the NSP where only one skill level is associated with each nurse. Maximizing the number of crewed missions and balancing types of missions further complicate the RASP.

The *airline crew scheduling problem* (ACSP) involves finding the minimal cost assignment of crews to a flight schedule while satisfying a variety of restrictions. Some solution algorithms not only assign crews to flights on the schedule, but also build the best schedule from possible alternatives. Ball and Roberts (3) and Marsten, Muller and Killion (6) used set partitioning approaches while Baker *et al.* (2) and Sherali and Rios (9) developed heuristic approaches. The ACSP differs from the RASP in several key factors. The ACSP normally includes numerous departure and destination points. Crews are formed units which are rarely separated, and each crew member has only one qualification. Therefore, the main problem is matching entire crews to the numerous possible flight profiles. The RASP possesses the unique aspect of each individual having many qualifications, while the flights scheduled do not vary.

Lee (5) presented a method for scheduling personnel for the Southwest Research Institute. This problem involved a set of binding and nonbinding constraints which included skill category requirements, number of personnel required, Nuclear Regulatory Commission regulations, and fairness (in terms of workload) to the individuals being scheduled. There were seven skill categories and five levels of certification within each category. A scheduled team was composed of a specified number of individuals with given qualifications. Lee's solution method consisted of a three-phase heuristic method using list processing and data structures. Phase 1 determined the set of feasible individuals for each job using the binding constraints. Phase 2 assigned feasible individuals to each team. Phases 1 and 2 were repeated using a variety of job, or team, input orders. Phase 3 chose between the possible schedules based on which best fulfilled the nonbinding constraints. Although this problem differs in some aspects, it more closely resembles the RASP than any other problem found in the literature.

The models cited have similar characteristics: they try to optimize an objective function which includes such factors as minimum cost, employee preferences, most experienced crew, and equal workloads; they match personnel to jobs over a given time frame; and the constraints are often numerous and complex. With the exception of Lee's manpower scheduling model, none of these papers address a problem where each employee has a large number of qualifications. In the RASP, each job requires a specific qualification and the jobs vary widely, not only within each daily schedule but also from day to day. Apparently, a manpower scheduling problem of this specific type has not been adequately addressed by the literature.

An Overview of the Heuristic Solution Method

As shown by Hanley (4), the RASP may be modeled as an integer programming problem. Unfortunately, RASPs of practical size give rise to integer programming formulations with over 6000 variables and over 1500 constraints. Since these formulations possess no special mathematical structure, they are impossible to solve within the limits of any practical computational effort. In addition, the dynamic nature of the RASP requires frequent changes of the parameter values in the integer programming problem. Specific causes of these parameter alterations include unstable availabilities of flying personnel and weather and maintenance problems. Due to the high degree of interdependency between jobs, the loss of a single planned job can have a rippling effect throughout the week. These facts precluded integer programming as a practical solution method.

After an investigation of other "exact" solution methods proved unfruitful, it became clear that our efforts should be directed at developing an effective and highly efficient heuristic approach. The following binding requirements and objectives formed the basis for the development of the method that was subsequently implemented in a system of BASIC microcomputer programs (4):

Binding requirements:

(1) All jobs must be filled.

(2) Only qualified individuals may be assigned to each job.

(3) Only one job can be accomplished at a time. No individual may be assigned to another job until after the completion time of any previous jobs.

(4) The time from the start of an individual's first job to the completion of his last job must be less than 12 hours.

Objectives:

(1) Fulfill all 6-month training period requirements as quickly as possible.

(2) Maximize the number of missions flown with crewed pilot/WSO teams.

(3) Minimize the number of missions flown that are not required.

(4) Distribute the flying jobs among the crewmen as evenly as possible.

These four objectives do not necessarily complement one another. For example, if we concentrated *only* on objective 2, the others would certainly suffer. Consequently, a successful heuristic approach must consider all four objectives simultaneously, obtaining a schedule which is a suitable compromise between them. In addition, the heuristic must be flexible enough to allow individual user preferences to determine what constitutes such a compromise.

The first thing that had to be determined was an algorithmic procedure for matching crewmen to jobs. Two possible approaches are (1) scan all jobs and fill the most critical job with an appropriate crewman, or (2) scan all crewmen and select the crewman who needs a job the most. An examination of the small sample problem given in Table 3 provides motivation and some useful insights.

Job 4 requires a skill possessed only by Steck. Likewise, job 8 must be filled by Stevens. If Steck and Stevens are assigned to jobs that conflict with performing jobs 4 and 8, respectively, the schedule becomes infeasible. Once Steck and Stevens are assigned to jobs 4 and 8, several other assignments are implied. Bilder *must* perform jobs 1 and 5; i.e., Stevens cannot perform job 1 because his workday would then exceed 12 hours, and he cannot perform job 5 because it overlaps job 8 (between 1700 and 1800 hours). Using similar logic, Bond must perform job 2 and Feller must perform job 7. For a feasible solution, only jobs 3 and 6 have more than one possible assignee. Feller or Stevens can perform job 3, and Steck or Bond can perform job 6.

			Remaining 6 Month Mission Requirements	
Number	Name	Capabilities	DR	NR
1	Bilder	A,C	5	1
2	Bond	B	4	2
3	Feller	C	3	0
4	Steck	B,D	0	0
5	Stevens	A,B,C,E	4	2

CREW ROSTER

Job No.	Start	Finish	Required Skill	Type
1	0800	1200	A	DR
2	0800	1200	B	DR
3	0900	1300	C	DR
4	0900	1300	D	DR
5	1400	1800	A	NR
6	1400	1800	B	NR
7	1700	2100	C	NR
8	1700	2100	E	NR

JOB SCHEDULE

Table 3: A Small Sample Problem.

From the viewpoint of obtaining a feasible solution, this small problem indicates that it is important to first fill those jobs that have the fewest available *candidates* (persons who may be assigned to the job without violating one of the four binding requirements). After determining a "best job" to be filled, it is still necessary to choose the best person to assign to that job. If feasibility were the only consideration, a generalization of the aforementioned method would suggest assigning the candidate that is able to perform the fewest number of unfilled jobs.

Although this generalization would enhance the prospect of achieving a feasible solution, it ignores the four objectives. If we are to include those objectives in selecting the candidates for a given job, we must incorporate several different factors. As indicated, the relative importance of each objective may not be the same for different schedulers and may change with time or circumstances. For this reason, the method must be adaptable to individual user preferences.

Selecting individuals by using a *weighted sum* of their abilities to meet each of the four objectives *and* to achieve feasibility satisfies these criteria. In the computer implementation of the heuristic, the user may vary these weights depending on his preferences. In addition, the user may set the value of the *bonus points*, i.e., a numeric value, associated with each of the "abilities." Using this technique, the question of which candidate to assign to a job is reduced to selecting the candidate who has the largest number of bonus points for that particular job.

Four factors that should be considered when choosing between candidates for a given job are:

(1) The number of unfilled jobs the candidate is qualified to perform.

(2) Whether the candidate is crewed with the person already assigned to the other job in the same mission.

(3) Whether the candidate needs the job to fulfill his 6-month training requirements.

(4) Whether the candidate is already assigned to other jobs.

There are two things that must be determined when considering how best to use factor (1). First, we must determine the point at which this factor becomes important. If Feller can do 17 and Stevens can do 14 of the unfilled jobs, the factor is probably not important in choosing between Feller and Stevens. However, if Feller can perform only 1 unfilled job and Stevens can perform 4 unfilled jobs, assigning Stevens the single unfilled job that Feller can perform will preclude Feller from working *any* of the unfilled jobs on the schedule.

The heuristic uses this information by first determining the number of unfilled jobs each candidate is qualified to perform. Next, the *minimum job availability number* (MJAN) is obtained. MJAN is an input value that allows the user to set the relative importance of assigning at least one job to candidates that have not previously been assigned a job. To allow this information to be weighted against all other goals, deviations *below* the MJAN must be multiplied by an inputted weighting factor, the *job availability factor* (JAF). The JAF allows the user to designate the importance of the number of potential jobs below the MJAN in the selection of a candidate for a given job. Examples of the number of bonus points given to each candidate for specific values of MJAN and JAF are shown in Table 4. (Note that while this scheme assumes a linearly proportional number of bonus points, other schemes could easily be implemented.)

UNFILLED JOBS CANDIDATE MAY PERFORM	MJAN=6 JAF=1 POINTS	MJAN=6 JAF=2 POINTS	MJAN=4 JAF=2 POINTS	MJAN=2 JAF=2 POINTS
7	0	0	0	0
6	0	0	0	0
5	1	2	0	0
4	2	4	0	0
3	3	6	2	0
2	4	8	4	0
1	5	10	6	2
0	N/A	N/A	N/A	N/A

Table 4: Examples of Job Availability Points.

The inclusion of this criterion helps in achieving feasibility for the daily schedules, in evenly distributing the jobs, and in satisfying the 6-month training requirements. If it is not important that bonus points be added for candidates able to do only a relatively small number of jobs, the user can set the values of MJAN and JAF accordingly. (Zero points will be allocated if either the MJAN or the JAF is assigned values of zero.) In addition, once a person has already been assigned to any job, he will *no longer* be given bonus points for being below MJAN when being considered for additional assignments. Otherwise, this method would encourage assigning multiple jobs to the least qualified individuals instead of evenly dividing the work.

The objective of maximizing the number of missions flown with crewed pilot/WSO teams is easily incorporated into the selection process. If a candidate is crewed with the person already assigned to the other job in the mission, then that candidate should be given extra consideration in the form of bonus points. Of course, if neither cockpit of the jet has been assigned, no bonus points are given. Again, the amount of points given for assigning crewed individuals must be determined by the preferences of the algorithm user. Assigning a large number, in a relative sense, to this variable will force the program to always first try to find a crewed candidate for a given job. If there are no crewed candidates available, the program will use the other objectives to assign an individual to the job.

The method used for including the remaining 6-month requirements with the other objectives is to simply augment each individual's bonus point total for this job by the number of missions he still requires for the type of job considered. For example, if the current job being assigned is part of a "day visual" (DV) mission, and Bond still needs 12 DV jobs, then give Bond 12 more points for any DV job. However, this method needs to be augmented to allow the user the ability to weigh the importance of this objective against the importance of all other objectives. For this reason, the heuristic requires the user to input a weighting factor, the mission requirements multiplier (MRM). The associated bonus points are obtained by multiplying the MRM times each person's remaining mission requirements.

While investigating different situations that arose from using the MRM, it became obvious that an additional correction to each person's point total was required. If Samuelson and Feller require ten and nine DV missions, respectively, then for relatively small values of the MRM, Samuelson would receive only a small advantage over Feller in vying for the given job. The same would be true if Samuelson needed one DV mission and Feller did not need any. However, in the latter case, if the job is assigned to Feller, the mission does not count towards fulfilling the squadron's objective of fulfilling the required missions for all aircrew members as soon as possible.

This would mean that another mission of this particular type must be generated in a future day's schedule because Feller flew a mission he did *not* require. This need for an additional mission can have serious consequences for certain mission types. Suppose a squadron plans to fly night missions only for a certain number of weeks. If all requirements are not completed in a timely manner, additional night missions must be flown, disrupting the plans of both the squadron and the maintenance unit.

The remedy used for this situation is to include a separate *penalty* if a candidate is being considered for a job for which he has no requirements remaining for the current training period. This penalty is in the form of *negative* bonus points and can be adjusted by the program user. This allows the user to increase the magnitude of the penalty as the end of the training period approaches, thus helping to ensure all mission requirements are fulfilled and to minimize the number of missions flown not required.

The final objective to be considered in choosing the best available candidate for a given job is to evenly divide the work. In the previous discussion of how best to use the number of unfilled jobs the candidate is qualified to perform, a method was described that enables the user to give a priority weighting to individuals who can perform only a limited number of jobs. Therefore, on a daily basis, we need only provide a method that will ensure individuals are not overworked. Because the definition of "overworked" may be ambiguous, the algorithm must allow the user to select both how many jobs per day is "too many" and what penalty should be assessed for exceeding this limit. This algorithm allows the user to select the penalty both for working two jobs and the penalty for

working three or more jobs. The possibility of being assigned to four or more jobs is extremely unlikely due to the time overlap constraints and the 12-hour duty period restriction. (Once more, other penalty strategies could easily be substituted for the one described.)

In summary, the heuristic finds the job which has the fewest number of candidates capable of being assigned and chooses the best of these candidates based on the four factors just discussed. The algorithm repeats these two steps until the schedule is filled or until the algorithm is unable to fill one or more unfilled jobs.

When no feasible assignment of crewmen to a particular schedule is possible, the approach outlined will quickly and efficiently determine that fact. However, there are certain highly structured schedule-and-squadron-personnel combinations that can cause the heuristic to fail to find a feasible assignment even when feasible assignments exist. In our experience with the heuristic, these situations occur *very rarely* and are usually resolved by marginally increasing the values of MJAN and JAF.

In the computer implementation of the heuristic, the user of the algorithm may also elect to allow the algorithm to schedule all jobs that can be filled with available personnel. Once the incomplete schedule is constructed, the user can either scratch the unfilled missions from the schedule or fill them with qualified personnel from sources outside of the squadron.

Computer Implementation of the Heuristic

In the computer implementation of any algorithm, it is important to access the necessary information using a compact and easily manipulated data structure. Of course, it is also important to select a data structure that is not overly difficult to modify when changes to the algorithm are required.

The minimum amount of information needed to make each decision must also be determined. For example, once we have determined whether a crewman is a candidate for a specific job, it is no longer necessary to track the actual qualification required for a given job or the qualifications of each individual. Therefore, by "preprocessing" the raw information, a minimum data structure can be built and then used by the part of the program which actually assigns individuals to jobs.

The raw information required by the algorithm is:

(1) A list of each crewman's qualifications, consistent with Figure 2.

(2) The squadron's formed crew roster (like that of Table 2) giving complete information on which individuals are considered to be crewed pilot/WSO teams.

For each day to be scheduled--

(3) A list of flying and nonflying jobs to be filled, consistent with the information given in Figure 1. This includes the start and end times, the type, and the qualification required for each job.

(4) A specification of job pairings (which pair of jobs are on the same mission).

(5) A list of each crewman's nonavailabilities due to previous commitments.

(6) A list of each crewman's remaining required missions for this training period for each type of mission. (This information must be updated after each day's schedule is completed, prior to scheduling the next day's jobs. The computer program for the heuristic performs this update automatically.)

User adjustable factors (default settings given in parentheses)--

(7) Minimum job availability number (= 5).
(8) Job availability factor (= 1).
(9) Crewed number (= 10).
(10) Mission requirements multiplier (= 2).
(11) Zero requirements penalty (= −10).
(12) Working two jobs penalty (= 0).
(13) Working three or more jobs penalty (= −10).

Assigning a number or index to each job and to each crewman allows a very simple method of entry for the raw information (as detailed in reference 4). The data structure used in the implementation of the heuristic is a rectangular *decision matrix*, A. Each element, a_{ij}, contains coded information about the relationship between crewman i and job j. A list of all possible values of the a_{ij} contained in the decision matrix and their meanings is given in Table 5. For example, if crewman 5 is a candidate for job 8 and still requires 6 more missions of the same type as job 8, a_{58} would be set equal to 6. If crewman 7 already had a meeting scheduled whose time conflicted with job 3, a_{73} would be set equal to −2. (The specific information contained in the different *negative* values can be important when partial rescheduling is required and it enhances the user-friendliness of the computer program.) With this type of data structure, the program for the heuristic can easily handle problems with as many as 80 individuals and 120 jobs on an IBM Personal Computer with 512K of random access memory.

Value of a_{ij}	Meaning of a_{ij} Value
$a_{ij} \geq 0$	Crewman i is a candidate for job j and a_{ij} is the number of jobs of this type that crewman i still requires.
$a_{ij} = -1$	Crewman i not qualified to perform the job j.
$a_{ij} = -2$	Job j conflicts with non-availability input for crewman i.
$a_{ij} = -3$	Crewman i is already working on another job at this time.
$a_{ij} = -4$	Someone other than crewman i has been assigned to job j.
$a_{ij} = -5$	Crewman i has been assigned to job j.

Table 5: Key to Meaning of a_{ij} Elements in Preliminary Decision Matrix.

The first step of the heuristic is to construct the *preliminary* decision matrix. This matrix has as many rows as there are crewmen and as many columns as there are jobs. It contains the crewman-job information before any jobs are assigned and is obtained by using items (1), (3), and (5) in the raw information input. From the preliminary decision matrix, we may observe whether a crewman can perform a particular job and, if not, whether the reason for his inability is due to a lack of qualification or a conflict with a previous nonflying commitment. If he can perform the job, then we may read directly the number of similar type missions he still requires during the training period.

For example, if we assume that Bond has a meeting to attend at 1700 hours, Figure 3 gives the preliminary decision matrix for the sample data provided in Table 3. (The crewmen numbers, crewmen names, and job numbers are listed as an aid in understanding the matrix, but are not part of the matrix.) Once more we see that job 4 requires a skill possessed only by

Steck, and he must be assigned to job 4 in spite of the fact that he does not require any more jobs of that type. Similar observations consistent with our earlier analysis of Table 3 may also be made with the aid of Figure 3.

The second step of the heuristic adds one row and one column to the decision matrix and stores the total number of candidates for each job in row zero and the number of unfilled jobs each individual can perform in column zero. These additions to the decision matrix of Figure 3 are shown (in boldface) in Figure 4. These values are obtained by counting the number of non-negative entries in each row and in each column, respectively.

		JOBS 1	2	3	4	5	6	7	8
1	Bilder	5	−1	5	−1	1	−1	1	−1
2	Bond	−1	4	−1	−1	−2	−2	−2	−2
3	Feller	−1	−1	3	−1	−1	−1	0	−1
4	Steck	−1	0	−1	0	−1	0	−1	−1
5	Stevens	4	4	4	−1	2	2	2	2

Figure 3: Preliminary Decision Matrix.

			JOBS 1	2	3	4	5	6	7	8
			2	**3**	**3**	**1**	**2**	**2**	**3**	**1**
1	Bilder	**4**	5	−1	5	−1	1	−1	1	−1
2	Bond	**1**	−1	4	−1	−1	−2	−2	−2	−2
3	Feller	**2**	−1	−1	3	−1	−1	−1	0	−1
4	Steck	**3**	−1	0	−1	0	−1	0	−1	−1
5	Stevens	**7**	4	4	4	−1	2	2	2	2

Figure 4: Secondary Decision Matrix.

Additional items of information can be stored in the *augmented* decision matrix as required. In general, let m equal the number of individuals and n equal the number of jobs for a given schedule. The third step of the heuristic augments the secondary decision matrix with three columns and five rows and assigns the following meanings to the elements of those new columns and rows:

column

(n+1)—the number of jobs each person has filled
(n+2)—primary crewed individual
(n+3)—secondary crewed individual

row

(m+1)—individual assigned to job j
(m+2)—job number that is considered a crewed job with job j
(m+3)and
(m+4)—individuals who, if assigned to job j, will be given the bonus for flying crewed individuals together in the same aircraft
(m+5)—type of mission of job j

Suppose the following statements are true for the sample data set of Table 3: Stevens is crewed with Bond and Steck (primary and secondary crews), Bilder is crewed with Steck and Bond, and Feller is not crewed. Jobs 1 and 2, 3 and 4, 5 and 6, and 7 and 8 are in the same aircraft, respectively, and DR missions are type 1 and NR missions are type 2.

Adding this information to the secondary decision matrix of Figure 4, in the manner described, yields the augmented decision matrix presented in Figure 5. This matrix is built by a preprocessor program and is used by the heuristic scheduling algorithm's program to assign individuals to jobs. As each job is filled, it is necessary to update the matrix to reflect the new information. When a person is assigned to a job, the program must have some means of knowing which jobs the assignee can no longer accomplish (because the duration of the newly assigned job conflicts with the duration of a job for which he was previously a candidate). Therefore, before we can update the decision matrix, a *job conflict list* must be formed from the information given in item (3) of the raw information. An example of this type of list, for the sample data in Table 3, is given in Table 6. Hence, a crewman assigned to job 3 can no longer be assigned to jobs 1, 2, or 4 because of the restriction that no crewman may perform more than one job at a time.

Once the first job has been assigned, it is necessary to update the decision matrix to reflect this assignment. If we scan the jobs by ascending job number, job 4 is the first to be filled for the matrix of Figure 5 and the only candidate is person 4, Steck.

			JOBS 1	2	3	4	5	6	7	8	*n+1* 9	*n+2* 10	*n+3* 11
			2	3	3	1	2	2	3	1			
1	Bilder	4	5	−1	5	−1	1	−1	1	−1	0	4	2
2	Bond	1	−1	4	−1	−1	−2	−2	−2	−2	0	5	1
3	Feller	2	−1	−1	3	−1	−1	−1	0	−1	0	0	0
4	Steck	3	−1	0	−1	0	−1	0	−1	−1	0	1	5
5	Stevens	7	4	4	4	−1	2	2	2	2	0	2	4
6	*m+1*		0	0	0	0	0	0	0	0			
7	*m+2*		2	1	4	3	6	5	8	7			
8	*m+3*		0	0	0	0	0	0	0	0			
9	*m+4*		0	0	0	0	0	0	0	0			
10	*m+5*		1	1	1	1	2	2	2	2			

Figure 5: Augmented Decision Matrix.

If two or more persons had been candidates for job 4, the algorithm would have evaluated the bonus points associated with that job for each of the candidates and selected the crewman with the greatest number of points. For example, if MJAN = 4, JAF = 2, MRM = 3, and the penalty for assigning a mission to a person who does not require such a mission is −1, Steck's bonus points for job 4 are computed as (MJAN − 3)JAF + MRM(0) − 1 = (1)2 + 3(0) − 1 = 1. Steck receives no "crewed" bonus points since the other cockpit is empty and no penalty points for multiple jobs since this is his first job assignment.

Since there is only one candidate, the algorithm proceeds with his assignment to job 4. Using the codes of Table 5, a_{44} is set equal to −5 and a_{14}, a_{24}, a_{34}, and a_{54} are set equal to −4. In a similar manner, all a_{ij} elements in the assignee's row (row 4) which conflict with the selected job must be set to −3. This requires use of the job conflict list in Table 6.

JOB	JOBS THAT CONFLICT
1	2, 3, 4
2	1, 3, 4
3	1, 2, 4
4	1, 2, 3
5	6, 7, 8
6	5, 7, 8
7	5, 6, 8
8	5, 6, 7

Table 6: Job Conflict List for the Jobs of Table 3.

There are several other elements that must be adjusted in the decision matrix. The job assignee's number must be placed in row (m+1) = 6 of the assigned job's column. For the sample matrix, a_{64} must be set equal to 4. Also, the elements in rows (m+3) = 8 and (m+4) = 9 of column 3 must be set equal to the numbers of the two individuals crewed with Steck (1 and

5); i.e., $a_{38} = 1$ and $a_{39} = 5$. Column 3 is used because job 4 is crewed with job 3. This fact is given by location a_{74}. Next, location $(n+1) = 9$ of the row associated with Steck (a_{49}) must be increased by one to show that Steck is working an additional job. Finally, all other $a_{4j} \geqslant 0$ whose jobs (j) are the same type as newly filled jobs must be reduced by one. This step is important because otherwise the algorithm might attempt to assign two or more missions of the same type to a person who requires only one mission of that particular type. For the sample problem, this adjustment is not required since job 4 conflicts with the other DR missions. All these changes to the decision matrix are reflected (in boldface) in Figure 6.

							JOBS				n+1	n+2	n+3
			1	2	3	4	5	6	7	8	9	10	11
			2	2	3	0	2	2	3	1			
1	Bilder	4	5	−1	5	−4	1	−1	1	−1	0	4	2
2	Bond	1	−1	4	−1	−4	−2	−2	−2	−2	0	5	1
3	Feller	2	−1	−1	3	−4	−1	−1	0	−1	0	0	0
4	Steck	1	−3	−3	−3	−5	−1	0	−1	−1	1	1	5
5	Stevens	7	4	4	4	−4	2	2	2	2	0	2	4
6	m+1		0	0	0	4	0	0	0	0			
7	m+2		2	1	4	3	6	5	8	7			
8	m+3		0	0	1	0	0	0	0	0			
9	m+4		0	0	5	0	0	0	0	0			
10	m+5		1	1	1	1	2	2	2	2			

Figure 6: Augmented Decision Matrix after Assignment of Job 4.

The process outlined is repeated until all jobs are filled. If the algorithm is unable to fill all jobs, the user may allow the algorithm to fill as many as possible and present the schedule with the unfilled jobs left blank. At the user's option, he may elect to try the heuristic again with increased values of MJAN and/or JAF. If there are any assignments that will allow all jobs to be filled, this parameter adjustment will assist in finding such an assignment.

Several additional features of the programmed version of the heuristic are discussed in detail in reference 4. Among these are (1) the ability to assign jobs on the squadron schedule to individuals that are not members of the squadron, (2) the ability to preassign specific individuals to specific jobs on the schedule before implementation of the heuristic, (3) the capability of revising the schedule in the event of nonavailability of scheduled personnel without changing other assignments (thus avoiding the disruption of premission planning at a late point in time), and (4) the capability of enforcing mandatory crewing in all scheduled missions (with the option of using flight instructors, squadron supervisors, and flight commanders as alternative "crewed" personnel).

Each of these additional features emphasizes the flexibility and power of this type of approach to the scheduling problem addressed in this paper.

Results and Directions of Future Work

As a practical test of the heuristic, a typical week of scheduling activity was performed at the 91st TRS both with the heuristic computer program (using the default settings for the user specified values) and with the "usual" by-hand method. While a detailed discussion of these results is given in reference 4, it is easy to summarize the overall findings of the study. On the average, the number of required missions scheduled during the trial week increased by over 10%, and the number of unneeded missions decreased by more than 10%. Both of these improvements were achieved with equal or superior numbers of crewed missions assigned and with no noticeable differences in the even distribution of flying jobs. While these results are from an admittedly limited study, they are uniformly favorable. In addition, the results were achieved with a computer based tool which requires *dramatically* less time and effort. The average problem consisted of about 40 jobs, 25 pilots, and 25 WSOs, and the average amount of computer time to complete a day's schedule was about 3 minutes (including floppy disk access time) on an IBM Personal Computer. Further, this decrease in time and effort was accompanied by a marked increase in flexibility and power available to the scheduler and decision maker.

The computer programs developed in this study are currently undergoing study and evaluation at TAC Headquarters. In addition, additional development of the technique is being performed at the US Air Force Academy and at the University of Texas at Austin. The primary thrust of this additional work is directed at expanding the scope of the technique to include considerations of the wing scheduling section and the flight management organization.

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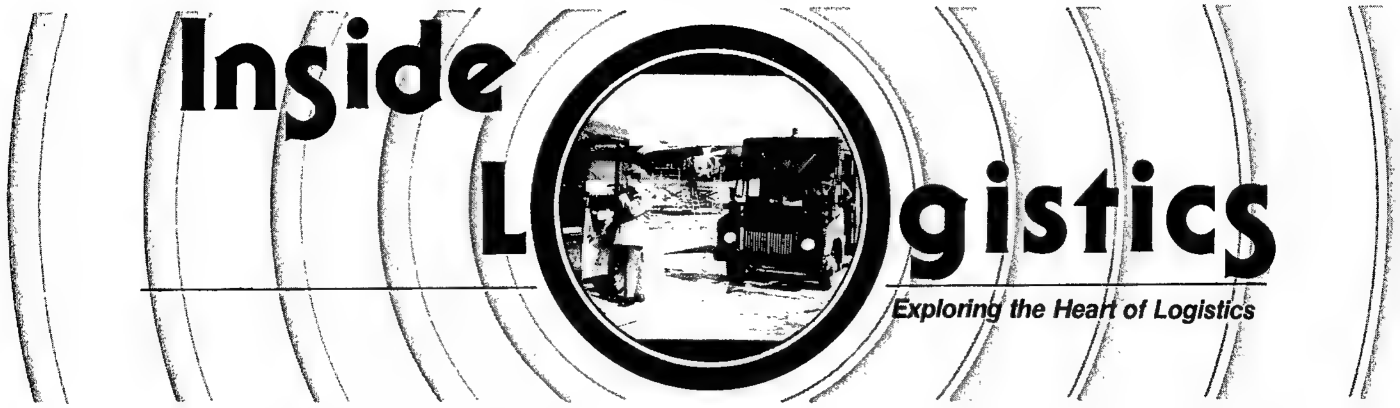

Readiness Oriented Logistics System (ROLS) in the Strategic Air Command

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Background

It has been about two years now since the term ROLS was first heard in the Strategic Air Command (SAC). ROLS stands for the Readiness Oriented Logistics System, which is the name given to SAC decentralized aircraft maintenance. ROLS was initiated to meet increased operations sortie requirements by moving decision making authority and resources to the flight line. During the Summer of 1985, General Larry D. Welch, then CINCSAC, authorized three units to develop a decentralized maintenance organization. These units established their own versions of ROLS and operated under those concepts. The units which tested the decentralized concept were the 92 Bombardment Wing (BMW), Fairchild AFB, Washington; 319 BMW, Grand Forks AFB, North Dakota; and 410 BMW, K.I. Sawyer AFB, Michigan.

Once the concept was established and working, evaluations began. A team of headquarters staff personnel visited Fairchild to observe and learn. In addition, the Deputy Commander for Maintenance (319 BMW and 410 BMW) briefed the ROLS organization to the LG and his staff. A command working group was then formed to recommend a single ROLS organization for SAC. On 2 June 1986, a conference was held at Headquarters SAC, chaired by General Welch and attended by NAF commanders, the three ROLS units, and members of the SAC staff. The ROLS organizational structure was finalized at this conference. Later that month, following CINCSAC change of command, the ROLS structure was approved by General John T. Chain before being released to the command. Originally, ROLS applied to bomber/tanker collocated units at SAC host bases. Currently, ROLS is also implemented at B-1B, KC-135, and consolidated aircraft maintenance units.

Proof of Concept Bases

Before looking at the finalized ROLS structure, we need to review the three proof of concept bases. Fairchild AFB dissolved the bomber and tanker branches within the Organizational Maintenance Squadron (OMS) and established two Aircraft Maintenance Units (AMUs). It split its bombers and tankers, and assigned equal numbers to both AMUs. It also divided its specialists—hydraulics, electronics, propulsion, bombing navigation, electronic countermeasures—into on-equipment (works aircraft) and off-equipment (component repair). The on-equipment specialists were then assigned to OMS. Avionics and Field Maintenance Squadrons (AMS/FMS) primarily worked off-equipment component repair. Job Control lost directing authority.

Grand Forks AFB also established two maintenance units in OMS—a Bomber Maintenance Unit and a Tanker Maintenance Unit. As evidenced by the titles, Grand Forks kept its bombers and tankers separated into two maintenance units. It also divided its specialists into on- and off-equipment and moved the on-equipment technicians to the flight line. Job Control's role was also reduced.

Finally, K.I. Sawyer AFB left the bomber and tanker branches intact in the Organizational Maintenance Squadron, although each branch did divide into flights to promote competition. Both the Avionics and Field Maintenance Squadrons divided their specialists into on- and off-equipment, similar to both Fairchild and Grand Forks. However, K.I. Sawyer then established a flight-line branch in AMS and FMS, moving its on-equipment specialists to these branches. Like the other two units, Job Control's role was reduced.

Principles of Organization

With these three organizational concepts in mind, I would like to examine the principles which evolved and that now govern the organization of ROLS in SAC:

a. Large specialist shops with heavy flight-line workload will be assigned to OMS.

b. OMS branch/flight chiefs are responsible and accountable for maintenance production.

c. Production Control functions in AMS/FMS are dissolved; shop chiefs are responsible for shop production.

d. Each bomber and tanker branch will have a minimum of two flights.

e. OMS specialists dispatch will be located on the flight line.

f. Maximum possible number of senior supervisors will be moved to the flight line.

These principles provide the basic guidelines for SAC ROLS organizations. From this point, we can take a detailed look at the ROLS organizational structure. Looking at the maintenance complex from the macro view (Figure 1), there are no apparent changes. The Deputy Commander for Maintenance (DCM) is responsible for management of the maintenance complex. There are still four maintenance squadrons: AMS, FMS, MMS, and OMS. Three of these squadrons will be examined in depth for ROLS changes. The

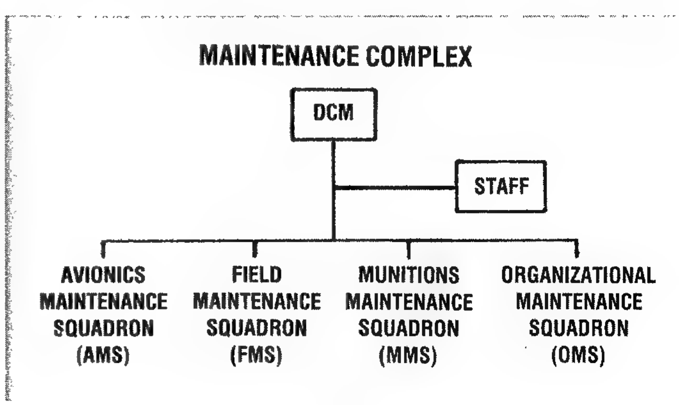

Figure 1.

fourth squadron—munitions maintenance squadron (MMS)—experiences no organizational changes under ROLS; but some procedural changes will occur due to other organizational changes.

The first changes become apparent when you look at the DCM staff (Figure 2). The assistant DCM is responsible for Training, Quality Assurance, and Administration. By administration, we are referring to administration for the DCM staff. The Assistant DCM for Production (ADCMP) is responsible for Analysis, Programs and Mobility, the Aircraft Readiness Center (ARC), and Plans and Documentation. The ARC was formerly known as Job Control. ARC monitors and coordinates aircraft maintenance—no longer directing maintenance. That function has moved to the flight line. The Plans and Documentation function handles emergency war order (EWO) contingency and maintenance plans, plus monitors aircraft hourly inspections.

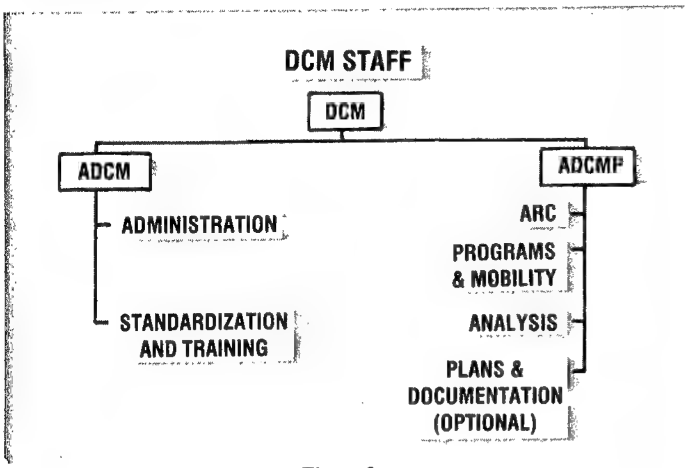

Figure 2.

In OMS (Figure 3), Plans and Documentation reports to Supervision. Alternate Mission Equipment (-21) and Tool Crib may report directly to Supervision or be divided into bomber and tanker branches. OMS may have up to four branches. The Alert Branch provides maintenance support for immediate launch of aircraft in support of strategic missions. The Inspection Branch performs major aircraft inspections (phase or periodic). To give the DCM flexibility, this branch is optional in FMS or OMS.

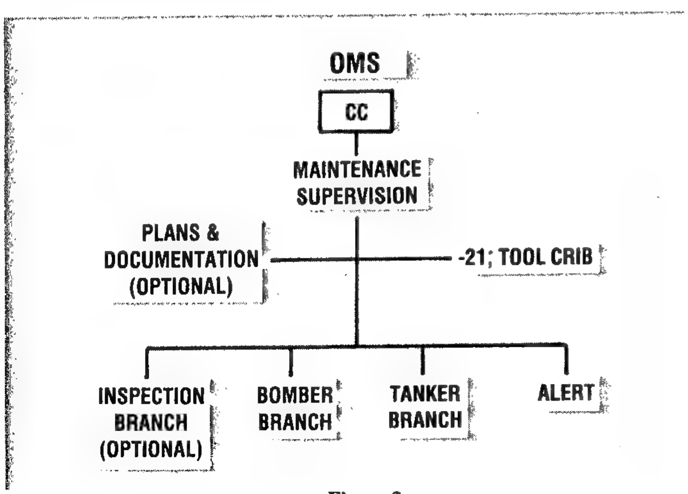

Figure 3.

Now we come to the heart of the maintenance complex—the Bomber and Tanker Branches. These branches show the most change under ROLS. The B-52 Bomber Branch (Figure 4) is enlarged with the addition of aircraft schedulers, debriefers, and on-equipment specialists from AMS and FMS. The key to this organization is the line chief—the senior noncommissioned officer who has the authority, responsibility, and resources to get the job done. This individual controls and directs maintenance on the flight line. If individuals have a question, they now call the "regular crew chief"—the line chief. Note that some of the specialties shown under the specialist flight are starred. Across the command, units differ radically in size. Due to this fact, smaller shops may not have enough personnel to split three ways—bomber branch, tanker branch, and shops. Therefore, the DCM has the option of assigning starred specialties to OMS branches or keeping them in the shops. The FB-111 Bomber Branch and Tanker Branch are organized the same way as the B-52 Bomber Branch.

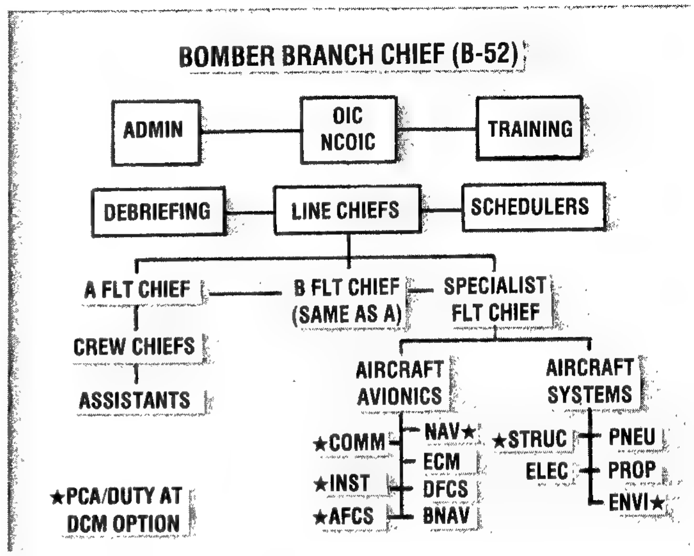

Figure 4.

AMS (Figure 5) is reduced in size due to the movement of specialists into OMS. The number of branches in AMS may vary from three to five. The Communication/Navigation Branch and the Autopilot/Instrument Branch are unchanged if those specialists remain in AMS (DCM option). Units may combine these two branches into a Flight Systems Branch. Off-equipment portions of Bombing Navigation, Electronic Countermeasures, and Defensive Fire Control plus Photo Shop constitute the Mission Systems Branch. However, if the unit desires, off-equipment portions of Electronic Countermeasures and Defensive Fire Control may be combined into the Defensive Systems Branch. These options provide units with flexibility—taking into account size, manning, and facilities.

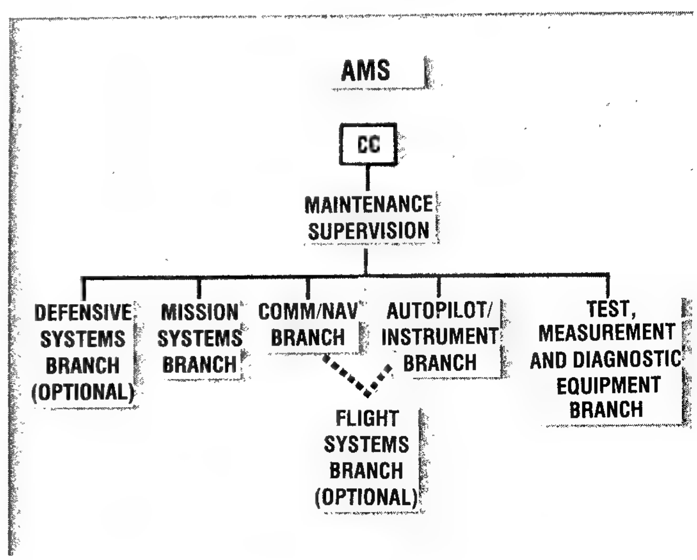

Figure 5.

Finally, FMS (Figure 6) has lost propulsion, electronic, and hydraulic specialists to OMS, but has gained non-powered Aerospace Ground Equipment (stands, tow bars) which is absorbed by the Aerospace Ground Equipment Branch. As discussed earlier, the Inspection Branch may be assigned to FMS if the unit desires. Repair and Reclamation/Wheel and Tire may be assigned to the Inspection or Aerospace Systems Branch—unit option. Units may also combine Aerospace Systems and Fabrication Branches into a Component Repair Branch. The final change concerning FMS is movement of the former Engine Management Branch (assigned to the DCM staff) to the Propulsion Branch as a section.

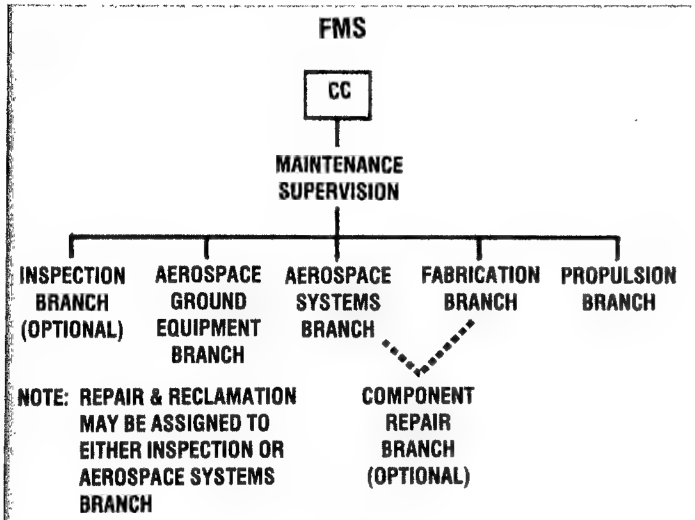

Figure 6.

Benefits of ROLS

Obviously, ROLS is a tremendous organizational change for SAC aircraft maintenance. The current command thrust is to allow units the organizational flexibility to meet their mission requirements—taking into account manpower and facility constraints. There are a number of benefits to be gained by ROLS. We are seeing increased efficiency on the flight line with better teamwork and more resources to do the job.

Additionally, ROLS makes the most of our NCO talent. By moving the decision-making authority to the lowest level, we develop stronger NCOs. We also give resources to a highly knowledgeable, experienced individual—the line chief. Finally, we have the ability to accommodate more sortie taskings because aircraft are fixed faster. The guidelines and regulations for ROLS are in the field. ROLS is dynamic and we expect changes and refinements to the organizational structure as units gain practical experience. The next few years will see continued change and perfection of ROLS.

Readiness Oriented Logistics System (ROLS) Update 1988

Initially, units showed desires for diverse organizational structures to accommodate individual missions. As we gain more experience under ROLS, units have moved closer together in basic structure and organizational philosophy. In August 1987, representatives from HQ SAC, Eighth Air Force, Fifteenth Air Force, and 15 units met at Barksdale AFB, Louisiana, and completed a total review of the ROLS organization and regulation which guides it. From that meeting, some adjustments were made. Changes included assignment of the plans and documentation function to the DCM staff (previously optional) and a name change—line chief to production supervisor. Other refinements were made in the regulation in order to accommodate unit desires.

We have to grapple with two serious difficulties under the ROLS concept—manpower shortfalls and training, especially for those specialists who moved to OMS. We have given our units a little more flexibility by allowing them to split those optional specialties and assign them to *either* the bomber or tanker branch. The only stipulation is that organizational balance be maintained between the branches.

Currently, training is the number one ROLS priority. We are beginning to address the difficulties of training in the OMS environment which requires cross-utilization training, or CUT. In addition, Rivet Work Force restructure efforts and conversion training are assisting the training effort under ROLS.

Rivet Work Force has also led to some refinements in shop/branch structure. The Flight Systems Branch structure is now the accepted branch structure in SAC. In fact, it is called the Conventional Avionics Branch. We have combined functions under this branch and have a communications/navigation shop and an instrument/automatic flight control shop. These AFSCs are combined under Rivet Work Force. Such changes will continue as Rivet Work Force takes shape and more AFSCs are affected.

ROLS was initiated in response to a requirement of CINCSAC for more sorties and deployable units—not as a cost savings or efficiency model. We knew from the TAF experience that decentralized aircraft maintenance is more manpower and equipment intensive.

ROLS has made the bomber and tanker branches more self-sufficient. We are now training more realistically and recent unit deployments have shown that the ROLS organization supports short notice, bare base operations better.

In addition to mission capability increases, some units have shown savings or gains in areas like man-hours per flying hour, delayed discrepancies, and aircraft fix times. Bottom line—ROLS still has problems, but we are progressing and know that we are working smarter in the long run.

Pacer Impact

The Key to Productivity

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What comes to mind when you hear the words Pacer Impact? Probably some abstract thought or concept. Well, the term may not be a household word today, but for the Directorate of Maintenance at Robins AFB, Georgia, it soon will be.

Pacer Impact is our Air Force Logistics Command (AFLC) Industrial Maintenance Productivity Improvement Program which is a command-wide effort to improve productivity through accountability, creativity, and technology. Management, recognizing that productivity is the lifeline of maintenance activities, established this program in October 1983. Development groups were organized at all levels making it possible to capture many different kinds of productivity initiatives and document their savings. These groups are Methods/Process Engineering, Workforce Development and Motivation, Technology Enhancement, Environmental, and Material Asset Management.

Through the work of development group members, productivity reaches the highest levels possible. These members investigate current projects and activities in their respective areas of expertise and then make decisions concerning which activities require further review or study.

Through this review process, initiatives are developed. Initiatives that constitute proposed changes in procedures, technology, methods, or other facets of the Depot Maintenance Industrial Activity are called

pilot projects. These pilots must be pioneering efforts and have the potential for generating productivity savings, either in efficiency or effectiveness.

Methods/Process Engineering Development Group

This group encourages methods improvements in all areas. Most successful initiatives are reported through the Suggestions or Value Engineering programs. The most vital initiatives are those that provide leverage; that is, they facilitate the improvement of processes and procedures across the command.

Recent initiatives include establishment of a network of contacts for 14 depot maintenance processes within both MA and MM, reorganization of the Pacer Impact Crossfeed Catalog by processes and products to make its information more accessible, and an exercise in selective dissemination of initiative data which we expect to at least double the number of crossfeed initiatives implemented.

Plastic Media Blast for depainting of aircraft worked at Robins is another ongoing project which saves both time and money. This method also greatly decreases the amount of hazardous waste generated.

The group is also planning to implement a Paperless LANTIRN Automated Depot providing shop floor control and technical data at the point of use. This will be a pilot project of value to all air logistics centers (ALCs). It will interface with new computerized systems (Depot Maintenance Management Information System (DMMIS) and Automated Tech Order System (ATOS)) when they come on-line.

Workforce Development and Motivation Group (WDMG)

This group is tasked to identify, review, and crossfeed initiatives that address work force issues which include recruitment, development, retention, training, career broadening, and motivational efforts. Through this process, the WDMG identifies reports and publishes productivity enhancing actions throughout the directorate. "The Productivity Press," which highlights individual awards, new technologies, method improvements, and various work force related concerns, is distributed on a regular basis. This communication also focuses on new projects being worked in the Directorate. In addition to "The Productivity Press," articles are forwarded to the Rev-Up (local base newspaper so the entire base community will be aware of the productivity efforts).

The current pilot project of WDMG is "The Big Picture" program. This video program will be designed to increase employees' awareness of how their individual jobs and assignments directly affect the WR-ALC, Air Force, and DOD mission. Division representatives from the local WDMG have either written entirely or helped to write their individual scripts. This video is different from the standard mission briefing because the employees are telling the story from a "worker" point of view.

Technology Enhancement Development Group

This group is tasked to improve new technology and to promote technology interchange between divisions within the Directorate of Maintenance and throughout the Center. Maintenance personnel are actively involved in several technology projects dealing with automation, lasers, and robotics.

A robotically controlled laser paint stripping system for removal of paint from aircraft components is in the procurement cycle for use in the Industrial Products Division. This system, when in place, will be beneficial in reducing the time to paint strip aircraft components and in helping to reduce the use of chemicals in this process. Increased mission requirements in supporting the F-15 aircraft have prompted a project within the Aircraft Division to paint F-15 aircraft robotically. To keep abreast of technological advances in business and industry, the technology group is involved in studies such as the Robotic Application Study and the Laser Application Study conducted by Honeywell and General Electric.

Environmental Development Group

The objective of this group is to increase productivity by reducing hazardous waste. Reduction of hazardous waste can be achieved in several ways. One method is improved management of waste after it is generated; for example, selling waste fuel to licensed burners to be used for energy or cleaning up solvents by distillation so they may be reused. This approach will always be necessary since it is unlikely that we will stop producing hazardous waste entirely.

The preferred solution is to prevent the generation of hazardous waste at the source. This can be done by relatively inexpensive changes to work procedures, by changes in the materials used in a process, or by capital intensive changes in equipment or technology. For example, machinists used a coolant fluid in their machines that was disposed of weekly. The fluid was being disposed of not because it stopped working but because it had an unpleasant smell. The foul odor which was due to growth of bacteria in the fluid was solved by using two measures. Improved cleaning techniques were used during fluid changes and a biostat coolant fluid was also substituted. Biostats retard the growth of bacteria. Coolant fluid is now changed every three weeks instead of weekly.

The change from vacuum cadmium to Ion Vapor Deposition (IVD) equipment is a good example of a technology change. Both processes are used to coat metals such as aluminum for corrosion protection. The older vac cad system coats with cadmium metal; the IVD coating is aluminum. The aluminum coating has proven to be superior to cadmium; less time is required for maintaining IVD equipment; and, most importantly, worker exposure to cadmium metal which is highly toxic is eliminated.

Material/Asset Management Development Group (MAMDG)

This group is comprised of representatives from each product division's material arena. Its objective is to identify problems in the material/asset arena and to identify and implement initiatives and projects that will improve the current procedures, systems, and facilities. In this era of limited funding, the MAMDG is focusing on initiatives that not only have cost savings but also cost avoidances.

The MAMDG currently has several projects to aid in the material/asset areas. Some of these projects are geared toward improved systems and procedures, inventory management, material handling, and better training of material personnel. The bottom line is to help the material/asset managers do a better and more efficient job.

PIIBS

Once Pacer Impact initiatives are developed, they must be documented. This documentation is accomplished through the Pacer Impact Initiative Benefit Summary (PIIBS). The PIIBS identifies the information generated from initiatives and serves as the official recording tool for all productivity improvements.

PIIBS may show tangible or intangible benefits, or budget savings or cost avoidances. They are essential to the productivity program because they provide us with a valuable measurement tool. Measurement of our productivity efforts leads to our goal of improving productivity command wide.

The actual recording of PIIBS is the responsibility of the Pacer Impact Productivity Principal. As the focal point for all productivity activities, the principal not only records PIIBS but also ensures that validation and verification are accomplished. Other duties of the principal include ensuring all initiatives are documented.

The Air Force has long been an advocate of productivity, and the maintenance community is proud to be a leader in pursuing productivity, through "accountability, creativity, and technology," throughout the work force.

Readiness: The Importance of Being Prepared for the Unexpected Peacetime Disturbance

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Introduction

Readiness is, above all else, a state of mind. Successful leaders are capable of making efficacious decisions which yield excellence in organizational performance. One of their most important characteristics is the ability to deal effectively with crisis situations. They know and understand their environments, both internal and external; therefore, they are able to anticipate the kinds of unusual events which can significantly impact organizational performance.

Informed military managers realize that environmental disturbances can have a positive or a negative effect on the performance of their organization. They view unplanned events as opportunities for gain and are capable of turning organizational threats into occasions for promising advances toward preestablished goals. The truly effective manager is able to assess problematic situations, create and evaluate alternative courses of action, and decide and implement appropriate action in a timely manner.

Traditional Approach to Planning

Military personnel are taught to define objectives, organize their resources, and pursue the objectives to successful conclusion. This rational approach to problem solving is effective when the objective is clear. It represents the traditional approach to planning. Every experienced manager, however, knows that problem situations are rarely, if ever, well-structured. It is unusual when plans are executed as written. Even routine operations are regularly interrupted by crises which divert resources and attention from the primary objective. Insightful managers promote self-confidence because they are prepared to act decisively and efficiently in situations for which others are not prepared.

It is important to note that unexpected organizational disturbances reflect opportunities to enhance mission achievement as well as threats to diminish these capabilities. While a manager needs to be prepared to address either situation, emphasis has traditionally been placed on responding to threatening disturbances. This focus reflects the fundamental orientation in the military toward promoting national defense.

Preparation for the Unexpected

Readiness is not an innate or intuitive characteristic. It requires thinking, planning, and continuously assessing threats which may confront an organization. Being prepared for the wide variety of low probability events will likely occur when managers are able to assess their environment systematically. This assessment improves their capabilities to handle potential disturbances that may impinge upon organizations.

Effective leadership involves a good grasp of the range of the most important situations and the ability to adjust organizational responses quickly should unexpected situations arise. The probability that a given situation will present itself in any particular time period is often unknown. There is also uncertainty about the outcome of actions taken in response to an environmental disturbance. These are facts of life which no manager can avoid.

Conscientious preparation for contingent events can improve the probability of success. Chance favors the prepared manager. To ignore preparation may deliberately invite the worst possible outcome. No one would advocate this latter option, but how does one best prepare to meet the unexpected? How can officers systematically survey the horizons of their environment and plan for unplanned events while concurrently involved with the myriad problems associated with routine responsibilities?

Thinking Comprehensively About Readiness

The idea that readiness in the military relates only to the ability to go to war reflects a narrow and unrealistic perspective. While the ability to carry out successful military actions in a hostile environment is absolutely essential, the well-prepared officer must also be concerned with the wide variety of non-war disturbances. Readiness must include preparations to deal with unexpected or crisis situations which arise during peacetime and to facilitate smooth transition from peacetime to wartime operating modes. Viewed in this sense, readiness needs to be considered in relation to a spectrum or continuum of events. Using perceived seriousness as a continuum dimension, Figure 1 identifies some representative disturbances which might be expected by an informed military base commander.

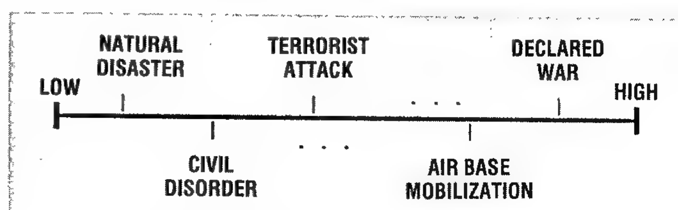

Figure 1: Continuum of Disturbances Capable of Disrupting Organizational Performance.

In most circumstances, a natural disaster is less threatening to mission achievement than a civil disorder or a terrorist attack. Conversely, a declaration of war is perceived as a greater threat to a military installation's viability than the receipt of a message requiring base mobilization. Any of these events may occur at any time to disrupt planned organizational performance.

Associated with the extensive variety of potential disturbances is an equally wide array of potentially effective responses. The systematic evaluation of multiple responses to each event on the disturbance continuum would be an overwhelming responsibility for all but the most conscientious officer. In contrast, planning for only one future scenario is seldom realistic for any military organization. However, there is an appropriate middle ground which allows managers to define a reasonable set of contingent situations and to test their assessment of readiness without undue burden.

Planning Support System

Although preparing for potentially disastrous disturbances seems intuitively obvious, using a planning support system to assist in this effort will require a change in perspective for many managers. A planning support system provides a structured approach to the analysis of all environmental factors that impact organizational performance. This difficult, but critical, step in planning is usually referred to as a situational analysis. The goal is to identify and classify all possible disturbances that may adversely impact the organization's capability of achieving its mission.

The process requires that managers lead their staff in a brainstorming session. This exercise is designed to produce a relatively exhaustive list of all disturbances that could affect the success of the organization to carry out its mission during the planning horizon. The planning support system provides a systematic process for classifying these disturbances and characterizing the nature of managerial effort required in developing appropriate disturbance responses. Figure 2 presents a flowchart which depicts a logical, yet balanced, approach to planning responses to threatening disturbances.

After a reasonably comprehensive list of potential organizational disturbances has been created, each event is classified regarding its importance. This rating is derived from a combination of its probable impact on mission success (if not responded to in a planned manner) and its occurrence probability during the planning horizon. Three relevant situations are possible:

(1) If the disturbance has the potential to influence the successful completion of the organization's mission significantly and also has a high probability of occurrence, then the manager should develop *multiple* effective responses and plan to implement the most effective one when the disturbance occurs.

(2) If the disturbance has the potential to affect the unit's mission significantly, yet has only a small probability of occurring during the planning horizon, then the manager should design a *single* effective response for implementation. As time permits, alternative responses should be developed.

(3) If the disturbance does not have the potential to impact the organization and its desire to carry out its mission significantly, then the disturbance is set aside. As time permits, a satisfactory response should be developed.

This planning support structure recognizes the limited managerial time and energy available to prepare for unexpected disturbances. Moreover, the structure uses a

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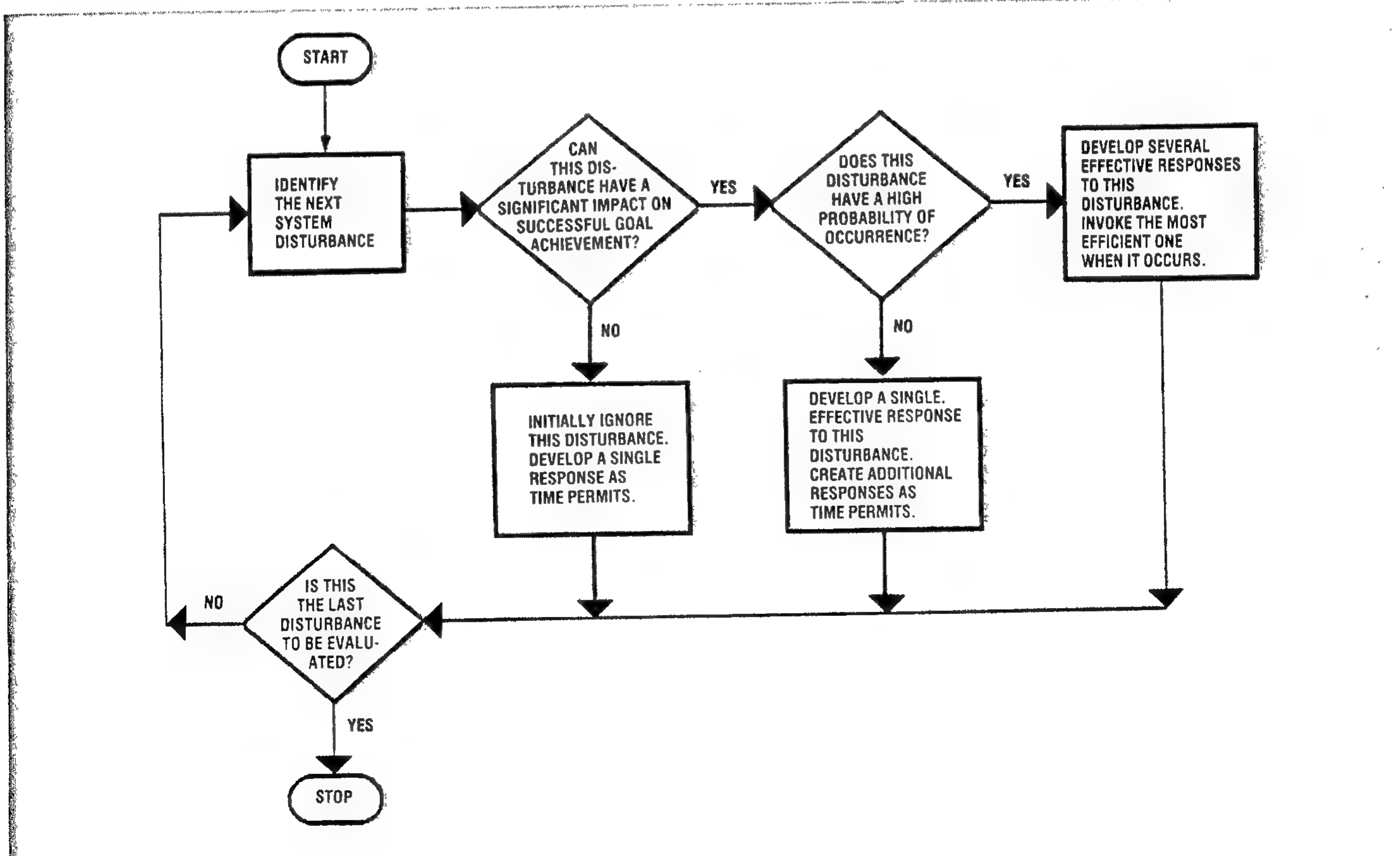

Figure 2: Process for Identifying Significant Potential Organizational Disturbances.

Air Force Human Resources Laboratory FY 88-89 Logistics R&D Program

The Air Force Human Resources Laboratory, Logistics and Human Factors Division, Wright-Patterson Air Force Base, Ohio, is the principal organization which plans and executes the USAF exploratory and advanced development programs in the areas of Combat Logistics, Acquisition Logistics, and Team Training Systems. Most of the Laboratory's efforts to improve Air Force logistics are managed within these sub-thrusts areas. Some efforts are undertaken in response to technology needs identified by the Laboratory, but the majority of the work is in response to formally stated requirements from various commands and staff agencies within the Air Force. Many of our projects vary from basic research aimed at producing new fundamental knowledge to applied projects which are intended to demonstrate the technical feasibility and military effectiveness of a proposed concept or technique.

Following are some logistics R&D projects managed by the Logistics and Human Factors Division, which will be active during FY88 and FY89. (Contact: Colonel Donald C. Tetmeyer, AUTOVON 785-3713, (513) 255-6797)

RELIABILITY AND MAINTAINABILITY IN COMPUTER AIDED DESIGN (RAMCAD)

OBJECTIVE: To develop methods and models to integrate reliability and maintainability (R&M) into weapon system design through the use of computer aided engineering (CAE) computer aided design (CAD).
APPROACH: Existing three dimension modeling techniques are being used for short-term demonstrations of R&M improvements which can be obtained with CAD technologies. The RAMCAD Software Integration Project, which is a joint effort with the Army Armament Research Development and Engineering Center, will accomplish three tasks: integrate R&M into a limited design process using CAE and CAD, conduct long-term R&D into two areas (developing R&M models and information management including applications of artificial intelligence to the design process), and develop an engineering curriculum which incorporates RAMCAD as an integral part. (Captain Don L. Lowdermilk, LRA, AUTOVON 785-6718, (513) 255-6718)

UNIFIED LIFE CYCLE ENGINEERING (ULCE)

OBJECTIVE: To develop, demonstrate, and transfer to application, the techniques and technologies needed to provide integration of design for producibility and supportability with design for performance, cost, and schedule.
APPROACH: Integration of existing research programs to change the design environment so all design attributes are appropriately addressed early in the design process. ULCE intends to take maximum advantage of current and future technologies in the areas of computer design, information technologies, decision support, and manufacturing technologies. (Alan E. Herner, LRA, AUTOVON 785-6718, (513) 255-6718)

COMPUTER AIDED DESIGN MODEL OF A MAINTENANCE TECHNICIAN (CREW CHIEF)

OBJECTIVE: To develop a computer-aided design (CAD) model of a maintenance technician to be used by weapon system developers to improve the maintainability and supportability of their designs.
APPROACH: CREW CHIEF is a computerized software model of an Air Force maintenance technician that will interact in real time with a designer's computer aided design workstation. The model will provide the designer with the capability to perform maintainability analyses while the design is still in the development phase. A major task in the development of CREW CHIEF is the ergonomic data collection effort that has provided data on accessibility, strength, and visibility. This program is a joint effort with the Harry G. Armstrong Aerospace Medical Research Laboratory (AAMRL). (Jill A. Easterly, LRA, AUTOVON 785-6718, (513) 255-6718)

IMPACT OF STRESS ON COMBAT MAINTENANCE ORGANIZATIONS

OBJECTIVE: To develop training programs to prepare aircraft maintenance personnel for future combat environments in order to reduce the potential negative impact of combat stress and to validate those programs.
APPROACH: After an extensive review of the literature was conducted, it was found that very little research has been accomplished in the area of combat stress and its impact on support personnel—specifically aircraft maintenance personnel. From that point, a two-phase approach was developed. In the first phase, potential training programs will be identified and developed which will provide realistic combat expectations; provide better individual coping skills; increase unit cohesion; identify basic symptoms of stress; and provide basic, simple treatments of stress reactions. The second phase will entail further refinement of, and validation of, the programs developed. (Cheryl L. Batchelor, LRC, AUTOVON 785-2606, (513) 255-2606)

INTEGRATED MAINTENANCE INFORMATION SYSTEM (IMIS)

OBJECTIVE: To develop an integrated information system for the flight line maintenance technician which will provide all the diagnostic, technical order, training, and work management data needed for job performance.
APPROACH: A series of design studies and prototype field tests will be conducted to establish the display formats, man-computer interface, and information requirements for IMIS. A prototype portable maintenance computer will be developed in conjunction with the development of interfaces for airborne and ground-based computer systems. The prototype will be field-tested to evaluate the design requirements for integrating and displaying maintenance information. (Major Ralph Kanko, LRC, AUTOVON 785-2606, (513) 255-2606)

COMBAT MAINTENANCE PERFORMANCE AND CAPABILITY (COMPAC)

OBJECTIVE: To field test and evaluate the combined effects of innovations in maintenance AFSC restructuring, manpower utilization, training, and advanced job aiding technologies on maintenance performance in the projected combat environment. Refinements are needed to streamline weapon system flight line sortie production, providing the capability necessary for decentralized, small-unit autonomy of operations.
APPROACH: A five-phase approach is projected. The first phase is being performed in-house and will result in a detailed research plan for project execution. The remaining phases will develop alternative maintenance support concepts, evaluate the impact of altered maintenance specialties, and investigate the impacts of technology applications in job aiding and technical training. A "test package" will be developed and field-tested in an operational aircraft maintenance environment to determine the ability to meet simulated combat tasking. Recommendations and transfer of project technology will be submitted to the implementing agencies for policy change considerations. (Richard E. Weimer, LRC, AUTOVON 785-2606, (513) 255-2606)

MAINTENANCE LIMITATIONS IN A CHEMICAL ENVIRONMENT

OBJECTIVE: To develop and validate methodology to determine how the performance of critical combat maintenance tasks is impacted by a chemical warfare environment. The methodology will be developed and then tested and applied in a simulated field, chemical environment. The data collected will also be input into combat models being developed by the Harry G. Armstrong Aerospace Medical Research Laboratory. All performance limitations observed will be isolated, identified, and reexamined. Suggested work arounds, policy and procedure changes, and equipment/clothing redesigns, as well as better methods of training in the chemical defense ensemble, are expected to result from this work.
APPROACH: Initial research design and data collection methodology was done in-house. During Phase I, the design and data collection methodology was refined. Phase II methodology was tested with data collection results sent to AAMRL for modeling inputs. Phase III concentrated on and isolated specific performance limitations discovered during Phase II. The limitations were further tested for a more exact isolation of the causes to determine the effects on combat sortie generation. Phase IV is bringing together the data collection in Phases I and II for an extensive analysis. Limiting factors, work arounds, and recommendations for present and future concern will be submitted through this phase. Phase V of this project is now being planned. It will look at the training transfer aspect of maintenance task accomplishment in the chemical ensemble. The expected result is a training package detailing the transfer of training relationships and suggesting a training approach. The training should capitalize on the task relationships and result in better maintenance capability for a minimum investment in training. This will allow maintenance technicians to work more efficiently and effectively. (Capt Alan Deibel, LRC, AUTOVON 785-3771, (513) 255-3771)

INTEGRATED MAINTENANCE INFORMATION SYSTEM (IMIS) DIAGNOSTIC DEMONSTRATION

OBJECTIVE: To evaluate the capability of maintenance technicians to perform complex on-equipment diagnostic tasks, and the associated remove and replace tasks, using an automated technical order system containing improved technical data.
APPROACH: A prototype portable computer has been developed that plugs into the maintenance bus on advanced aircraft. This portable aid will download the built-in test data that resides on the bus and then will incorporate that data into the diagnostic algorithm contained in memory. The technician will be given the next best test until the fault is found. Then remove and replace instructions will be provided at the appropriate level of detail for the technician. Two organizational level demonstrations are planned. The first is with an F-16 A/B aircraft. A small sample set of faults will be inserted on the aircraft. The prototype portable aid with improved technical data, including diagnostics, will assist the technicians in performing the fault detection/isolation and the necessary corrective actions. The second demonstration is with the Navy's F/A-18 aircraft. Improved technical data and presentation systems will be incorporated into the portable aid, based on the learning experiences of the F-16 demonstration. The sophistication of the built-in test capability on the F/A-18 will permit a field test that demonstrates the future potential of advanced, job aided, interactive, on-equipment diagnostics. (Capt Mike Seus, LRC, AUTOVON 785-2606, (513) 255-2606)

AUTHORING AND PRESENTATION SYSTEM (APS)

OBJECTIVE: To develop and test methods for creating, maintaining, and displaying interactive electronic maintenance information.
APPROACH: Building upon previous work, this effort has resulted in a system which allows a technical writer to create maintenance information on a user-friendly workstation without knowledge of how the information will be displayed to the technician. The neutral data base of maintenance information can be represented in the Standard Generalized Markup Language (SGML) or in data base tables. Information can be extracted from the data base and can be accessed in a variety of ways to meet the various needs of the maintenance environment. The programs are machine and operating system independent. (Lt Mark J. Earl, LRC, AUTOVON 785-3871, (513) 255-3871)

MISSION RELIABILITY MODEL (MIREM) ENGINEERING WORKSTATION

OBJECTIVE: To develop specifications for hosting MIREM on an engineering workstation. This Phase I Small Business Innovative Research (SBIR) will investigate putting MIREM on a workstation where it can interactively run with other circuit design tools. MIREM, already fully developed, evaluates the reliability of new fault-tolerant, electronic circuits during the early stages of system development. A prototype software interface will be developed that will permit the exchange of data between MIREM and other software tools.
APPROACH: The approach is divided into six tasks: define the requirements for the workstation, identify workstation candidates and their capabilities, define the MIREM workstation interface, describe the interface using data interchange standards, build a prototype interface writer/reader, and test the interface with a sample applications problem. (Capt Douglas A. Popken, LRL, AUTOVON 785-8419, (513) 255-8419)

PRODUCTIVITY IMPROVEMENTS IN SIMULATION MODELING (PRISM)

OBJECTIVE: To develop a prototype software environment that supports the life cycle management of logistics capability assessment simulation models.
APPROACH: Many simulation models used in logistics capability assessment are difficult to use, modify, or maintain. The PRISM approach to addressing these deficiencies will be to develop a prototype Integrated Model Development Environment (IMDE)—a software environment, resident upon a computer workstation, designed to use modular, hierarchical, object-oriented information structures. The environment will be designed to shift emphasis from "a model" as a product of research to the support of rapid, interactive, and exploratory modeling processes. The success of the project is dependent upon the successful exploitation of technological advances in object-oriented data bases, visual interactive programming techniques, and object-oriented programming. (Capt Douglas A. Popken, LRL, AUTOVON 785-8419, (513) 255-8419)

WARTIME LOGISTICS DEMAND RATE FORECASTING

OBJECTIVE: To provide a means for predicting, measuring, and testing wartime demands on logistics resources worldwide. Combat data will be collected and used to describe the difference between peacetime and wartime demand rates. These data will be placed in a computerized data base and analyzed in order to develop the necessary tools to perform the forecasting of wartime demand rates.
APPROACH: This study has been divided into five tasks: collect combat data, analyze combat data, insert data in a retrieval system, develop automated analysis packages, and document and transition results. The end products of this study are software, user's guide, programmer's guide, and applicable combat data bases. (James C. McManus, LRL, AUTOVON 785-8418, (513) 255-8418)

UNIFIED LIFE CYCLE ENGINEERING (ULCE) DECISION SUPPORT SYSTEM (DSS)

OBJECTIVE: To develop a decision support system, which can be incorporated into computer aided environment, in order to assist the designer in improving the characteristics of the design. The DSS will help the designer consider the relevant attributes during the appropriate design phases and will allow the designer to arbitrate between conflicting goals. The consideration of as many "ilities" as early as possible in the conceptual design phase will reduce weapon system life cycle costs and improve overall warfighting capability. The DSS is an integral part of the larger unified life cycle engineering process.
APPROACH: The primary task of this project is to develop, demonstrate, and transfer the technologies needed to provide integration of "design for supportability" and "design for producibility" with design for performance, cost, and schedule into a decision support system. The results of the DSS project will be incorporated with newly developed "ility" analysis tools and an information management process into a ULCE workstation. The workstation will provide an environment where the designer can evaluate relevant attributes such as reliability, producibility, performance, cost, and schedule early in the design process and arbitrate between conflicting design goals. Transition of the DSS to a workstation is expected in 1991. (Capt Richard B. Berry, LRL, AUTOVON 785-8418, (513) 255-8418)

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derivative of the classical control concept of management-by-exception as an aid to the first step in planning; namely, the identification of potentially critical organizational disturbances.

Management Implications

Managers have always recognized the possible organizational impact of critical events and have planned actions to mitigate their influence. Usually this has required an assessment of a wide range of contingent possibilities, all of which could degrade mission performance. Experienced managers with limited resources have coped with these situations by knowing they could employ available assets in a wide variety of combinations. Moreover, they realized that resource shortfalls in one area can often be compensated by the relatively inefficient substitution of different resources from another area. In short, these officers have learned to work around a less-than-adequate resource base and improvise when planned responses proved to be less than totally effective.

Peacetime efficiency considerations tend to reduce organizational capabilities to their lowest acceptable level for routine operations. Carried to its extremes, little organizational flexibility remains to deal with unusual but critical events. Every disturbance to routine operations results in a diversion of resources from planned essential work. This, in turn, can degrade operational performance and may foster a lack of confidence in existing managerial capabilities.

Plans for actual combat or combat support missions precisely tailored to a single scenario may not permit effective responses when environmental conditions change. This situation demands creative managerial insights or responses from an informed manager who has done some contingency planning. In sum, effective managers must be able to define their needs for flexibility and articulate them convincingly in an atmosphere of severely constrained resource availability.

"The United States today has roughly the same massive array of military obligations across the globe as it had a quarter-century ago, when its shares of world GNP, manufacturing production, military spending, and armed forces personnel were so much larger than they are now."

The Rise and Fall of the Great Powers
by Paul Kennedy

CAREER AND PERSONNEL INFORMATION

Civilian Career Management

PALACE ACQUIRE Intern Program

The PALACE ACQUIRE (PAQ) Intern Program is training a select number of highly motivated college graduates to become the future leaders of the Air Force. The Logistics Civilian Career Enhancement Program (LCCEP) is one of the many career management programs participating in this effort.

We recruit PAQ interns by sending functional representatives from the logistics community to interview potential PAQ interns at various universities. Generally, we select colleges offering a degree plan that will furnish candidates with the educational background needed to fill positions in logistics. The majority of the interns are recruited on college campuses selected for their academic programs in logistics management, business administration, or transportation. Recruitment is targeted toward graduating college seniors or candidates for advanced degrees.

We provide immediate feedback to interviewees by mailing a firm job offer to all selectees before leaving the college campus. This process notifies the selectees of their specific job offers pending successful completion of all degree requirements and the awarding of the degree.

PAQ interns are usually recruited for various positions throughout the major commands in the Air Force. The starting grades of the logistics positions are GS-5 or GS-7 depending on the candidate's grade point average and the availability of the specific positions. The training period is normally two to three years depending on the starting grade and the target grade of the position.

During this training period, the PAQ interns are assigned to one of many functions in the logistics community. PAQs at base level operations are usually afforded the opportunity to work in various base level supply functions before reaching key managerial positions.

PAQ interns are currently working and training as logistics management specialists, production specialists, inventory management specialists, and operations research analysts. These interns are currently assigned to six major commands and work in 35 different locations. We expect these interns to be working important positions at major command level after a few years' experience at field level.

The Air Force may require an intern to relocate during or after completing the training program; therefore, all PAQ interns are required to sign a mobility agreement. Generally, major commands expect to place the interns at their training site after completing the program. If a permanent position is not available, the intern will be required to relocate to another available position within the Air Force.

Since the inception of the PAQ program within the logistics community three years ago, 77 PAQ interns have completed the training program and are actively working as logisticians in many different functional organizations. We expect continued emphasis on the PAQ Intern Program as a vital source of tomorrow's leaders.

(Mr Ron Wong and Ms Vicky Guerrero, AFCPMC/DPCMLR, Randolph AFB TX 78150-6421, AV 487-5351)

LOCATION OF POSITIONS FILLED THROUGH LCCEP

LOCATION	NUMBER OF POSITIONS
Wright-Patterson AFB, Ohio	351
Hill AFB, Utah	301
Tinker AFB, Oklahoma	266
Kelly AFB, Texas	263
Robins AFB, Georgia	202
McClellan AFB, California	181
Pentagon, Washington DC	46
Scott AFB, Illinois	41
Norton AFB, California	38
Los Angeles AFS, California	37
Newark AFS, Ohio	35
Eglin AFB, Florida	34
Hanscom AFB, Massachusetts	33
Randolph AFB, Texas	26
Andrews AFB, Maryland	24
Battle Creek, Michigan	16
Langley AFB, Virginia	16
Travis AFB, California	11
Other Locations	248

For a complete listing of specific positions, see your servicing personnel office.

(AFCPMC/DPCMLO, Randolph AFB TX 78150-6421, AV 487-4088)

Logistics Professional Development

Potential Squadron Commander Lists

To help commands identify and select qualified officers for Mission Support Squadron Commander billets, AFMPC produces lists of potential candidates twice a year—March and September. These lists are then forwarded to MAJCOM Directors of Personnel for use in selecting officers to meet MAJCOM Squadron Commander boards or in working specific Squadron Commander nominations. Currently, AFMPC produces Potential Squadron Commander Lists for the following AFSCs: 31XX (missile maintenance), 40XX (aircraft/munitions maintenance), 55XX (civil engineering), 60XX (transportation), 62XX (services), 64XX (supply), 66XX (logistics plans) and 81XX (security police).

The Potential Squadron Commander Lists provide the MAJCOMs with maximum visibility of potential candidates, affording the officer increased opportunity to command, since all MAJCOMs are considering them. The lists identify candidates for a specific period of time—generally the next year's Squadron Commander requirements—and are screened based on an officer's records, eligibility to move (time on station/controlled tour, etc.), and overseas vulnerability. As officers are selected, the appropriate assignment team updates the Potential Squadron Commander Lists for their AFSC.

The MAJCOMs indicate these lists are very effective in ensuring quality officers are being placed in key command jobs.

(Lt Col Thomas J. Maxson, AFMPC/DPMRSL2, Randolph AFB TX 78150-6421, AV 487-4024)

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Air Force Logistics Management Center
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"Although the United States is at present still in a class of its own economically and perhaps even militarily, it cannot avoid confronting the two great tests which challenge the longevity of every major power that occupies the "number one" position in world affairs: whether, in the military/strategical realm, it can preserve a reasonable balance between the nation's perceived defense requirements and the means it possesses to maintain those commitments; and whether, as an intimately related point, it can preserve the technological and economic bases of its power from relative erosion in the face of the ever-shifting patterns of global production."

The Rise and Fall of the Great Powers
by Paul Kennedy